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**An exploration of factors that affect students' uptake of A-level sciences & the trajectories followed in making these choices**

El-Damanawi, Marwa

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# AN EXPLORATION OF FACTORS THAT AFFECT STUDENTS' UPTAKE OF A- LEVEL SCIENCES & THE TRAJECTORIES FOLLOWED IN MAKING THESE CHOICES

Marwa El-Damanawi

Kings College London

School of Education, Communication & Society

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## Abstract

This study gives a nuanced analysis of post-compulsory uptake of Science, by developing the ‘story’ behind the ‘London effect’. A two-phase mixed methods approach looked at the subject selection strategies of A-level Science students in inner London. The first phase consisted of a survey where 150 students, aged 16-17, were invited to answer a range of questions focused on their self-concept of Science, as well as their experience of Science inside and outside of school. The second phase involved interviews with a purposive sample of 22 of the initially surveyed students. These were analysed thematically based on an adapted version of the trajectory framework put forward by Cleaves (2005).

The study classified the emerging themes into groups based on how much control a student had on them. Findings show that the factors that students had limited control over (school-related factors, teachers, family & society, gender and socioeconomic background) affected the student’s choices through their effect on the three student-based factors; interest, ability and aspirations. When there was congruence between all three of these factors students followed a direct trajectory. If there was congruence between any two, then student trajectories were likely to be either partially resolved or funnelling identifier. Students who had no congruence between the three factors followed either a precipitating or multiple-projection trajectory.

This study highlights the necessity of clear objectives for initiatives that intend to increase student uptake of the Sciences. As such it has implications for practice suggesting that increasing participation in the Sciences post-16 would benefit from applying a three-pronged approach to encouraging students. Alongside developing their interest in the Sciences, we need to raise students’ Science ability (and their perceptions of it) as well as help them to develop well-founded career aspirations

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## List of abbreviations

A-level	Advanced level
ALIS	A-level Information System
BSA	British Sociological Association
DCFS	Department of Children and Family Service
DfE	Department for Education
GCSE	General Certificate of Secondary Education
NPD	National Pupil Database
OECD	Organisation for Economic Co-Operation and Development
OFSTED	Office for Standards in Education
PISA	Programme for International Student Assessment
QCA	Qualifications and Curriculum Authority
ROSE	Relevance of Science Education (study)
SES	Socio-Economic Status
SET	Science Education Technology
SPSS	Statistical Package for Social Sciences
STEM	Science, Technology, Engineering and Mathematics
STS	Science and Technology in Society
TIMSS	Trends in International Mathematics and Science Study

## Structure of the thesis

**Introduction** - The study is contextualised using the relevant developmental history of the Science teaching curriculum, uptake statistics and its focus on inner London Science students.

**Literature Review** - Contains a review of research into the various factors identified as affecting student uptake at A-level. There is a discussion of the useful aspects of several models offering insight into how students make choices. These informed the research questions, as well as the development of a framework for the project.

**Methodology** - Includes a description and justification of the research methodology. It also discusses the tools chosen to address the research questions, the limitations of the methods used and the approach to data analysis for each phase of the study.

**Analysis & Findings of survey data** - Presents the findings from the questionnaires using quantitative analysis and looks at students' experiences of school Science, as well as a range of factors and attitudes that correlate with the total number of A-level Science subjects studied.

**Analysis & findings of Interview data** - Choice trajectories are identified using individual narratives of students and interviews explore the descriptions of how the factors outlined within the literature review affected the interviewees within their decision-making process. The section also includes an exploration of the links between different factors, as well as between the congruence of factors and the overall trajectories followed by the students.

**Discussion & Conclusion** - Offers critical reflection and discussion of the findings and concludes the thesis by reflecting on the unique contribution of the study within the wider research area. It also explores its limitations, as well as highlights possible avenues for further investigation.

**References**

**Appendix**

## Introduction

### The developmental history of the Science teaching curriculum

A hundred years ago, Science was a 'new' subject that was hardly taught in schools at all (Delamont, 1989). During this time, leading universities - such as Oxford and Cambridge - did not rate Science as highly as classical subjects such as the mathematics and the arts; a time where public schools refused to teach Sciences while government schools did. As far back as 1860 Lord Wrottesley, President of the Royal Society, wrote 'it would be an unwholesome and vicious state of society in which those who are comparatively unblest with fortune's gift should be generally superior in intellectual attainment to those above them in station' (Jenkins, 1989).

In 1847, James Wilkinson, a member of the Royal College of Surgeons in London gave a lecture titled 'Science for All'; he explained that the ends for which the scientists create knowledge and those who seek the application of knowledge are not the same (Hurd, 1998). This same dilemma has been repeated in history many times since, by government reports as well as reformists (Aikenhead, 2006; DeBoer, 2000; Delamont, 1989; Hodson & Prophet, 1994; Hurd, 1998; Lemke, 2001; Millar & Osborne, 1998b; Osborne & Collins, 2001).

Various arguments have arisen suggesting why Science education is needed. There were those such as Bell (1915) who saw benefit in teaching the scientific method of thinking, as well as others who felt the need for scientific knowledge by committees such as 'Neglect of Science' saw it as key to our political effectiveness (Smith, 2010). There was also the Taunton Committee in 1867 who identified five arguments for the teaching of Science. These were: to develop the reasoning ability of students; to provide a well-rounded education; to enable them to be better citizens; for enjoyment as well as for its usefulness (Tolley, 1996). These reasons are still ones that we argue make Science education so relevant today.

In the days where Science education was optional or in most cases reserved for the privileged, motivation was not an issue since those who were studying it generally desired

to learn. The need for a significant change in the curriculum was building up since the Science curriculum first became compulsory in 1989. The National Curriculum made it mandatory for all students to study Science until the age of 16. With a wider range of students having access to education, it has become increasingly clear that the curriculum needs to cater for the requirements of these individuals to prepare them for their futures. There were some attempts made to ensure that those specialising in the Sciences had rigorous training for future studies, while those who were not academically motivated could still benefit from Science lessons. These included attempts to cater for the less academically motivated pupils including projects such as Nuffield Science 13-16 and LAMP project (Stevens, 1978).

In January 1998 two leading academic Science education researchers, Rosalind Driver and Jonathan Osborne led a series of seminars and meetings to ‘consider and review the form of Science education required to prepare young people for life in our society in the next century’ (Millar & Osborne, 1998a). As a result of these discussions, there was an emphasis on developing scientific literacy and student engagement with socio-scientific issues. With such a low proportion of students pursuing further study in Science, the Science curriculum at the time was not serving the majority of students. For the vast majority of students, the position of Science as a core compulsory subject had been taken for granted, and research supported this (Champagne & Newell, 1992; Millar & Osborne, 1998a; Osborne & Collins, 2001; Sjøberg, 2000). The policy change that followed from this was ‘the outcome of conflict and struggle between interests in context’ (Ball, 1993), where the socialisation aspect for the majority gained precedence over the knowledge aim for the specialising scientists.

Another problem that had been building up was a lack of context to the scientific knowledge taught. The scientific knowledge had advanced drastically over the last century, and this may have caused the curriculum to become more fact driven. The content-driven syllabus meant students might have found it difficult to make sense of the facts or understand the links between them. This focus may have led to a decrease in motivation for the lower ability students who simply may not have been able to cope with the quantity of the information, as well as disengagement of the higher ability students who may not have been able to apply the knowledge into the context of their everyday



lives. According to international reviews, many students opted not to pursue Science as soon as they had a choice (Jenkins & Nelson, 2005).

Science education has always had a wide range of formal and informal aims. On a classroom level, these have most prominently included teaching Science content, the nature of Science and developing scientific literacy. However, there have also been other broader demands on the curriculum, which include economic, political, social, environmental and cultural interests (Fensham, 2009). These demands result in tensions which can affect the emphasis on each of these curriculum aims. Schulz (2009) suggests that there are three main conflicting conceptions of Science education which compete and undercut each other. The three competing goals of Science education are knowledge itself (equipping students with factual knowledge about Science), personal development (helping students to think and reason scientifically) and socialisation (to prepare students to live, and engage, in a more scientifically advanced society). In the long-term, these competing aims have led to frequent changes in policy and a lack of stability in the field. The summary of some of these key changes and developments are in Appendix 1.

While some research focused on styles of teaching and learning techniques to help improve the situation, there were more fundamental studies which questioned the foundations and emphasis within the whole curriculum and pushed for reform. They doubted the rationale of a curriculum which catered for the needs of the minority of students who pursue Science degrees while compromising the needs of students who formed the vast majority of society. They questioned a curriculum which was so full of factual knowledge that it minimised the time that could be spent reflecting on the implications of the scientific models and applications of them on society (Jenkins & Nelson, 2005; Lyons, 2006; Osborne & Collins, 2001; Reiss, 2000; Ryder, 2001; Sjøberg, 2000). The reforms led the way to not just a change in the Science content delivered, but more pivotally they altered the aims of the profession by bringing the needs of the majority of students into the spotlight and provided a mechanism towards meeting them. The key tension that arises in the social function of Science education appears to be between developing the scientific literacy of the students who do not necessarily wish to pursue a career in the Sciences and developing the scientific knowledge and process of those who do.

In response, the UK government put into place a new Science curriculum for first teaching in 2006 with a wider variety of options. All students would continue to study Science. Those who wanted to specialise in Science had the opportunity to study for three separate GCSE Sciences in Biology, Chemistry and Physics. Those who were not necessarily planning on a Science-based career continue a double award course, equivalent to two GCSEs. Along with this, the focus shifted from a more content-based curriculum (pre-2006) to one that had more context; thus, developing the students' scientific literacy to prepare them for living in a more technologically based society. Another intended outcome of this change was to help motivate more students to take up the study of Science post 16.

The 2006 reform was unique compared to other statutory curricula changes in its development; from the grassroots, i.e. through teachers and educators as opposed to a government-dictated approach. The use of recent research to recommend and then affect change within the field was a big step for Science education. It meant that there was an opportunity for academic researchers and professionals in the field of Science education to be more autonomous about the future of the profession and how they believed it should be changed to make it better. Of course, this was within the constraints of budget, as well as working within the confines of other regulatory bodies such as Ofqual and the examining boards not involved in the pilots. The reform was also unique as it was not based solely on theories of learning. It utilised the experience of professional researchers in Science education who were directly involved in projects such as the Nuffield Foundation and Science and Technology in Society (STS) about the role of context in Science education over the past twenty years (Bennett, Lubben, & Hogarth, 2007). To some extent, this was a shift of power away from academic scientists who had dominated school Science by it being in their image and giving some of the control back to Science education researchers. These educators were arguably more qualified to use their professionalism to select a relevant and appropriate curriculum for the students. This reform was based around catering for the needs of all students and engaging all students in Science in a way that was suitable for whichever career path they chose to pursue. It managed to clarify that the benefits of Science education were not limited to aspiring scientists but would indeed be relevant for all students; changing the social function of the profession for the 90% of students who would have otherwise left Science behind.

With the reforms since 2006 focusing on ‘Science for All’ and developing ‘scientific literacy’ for citizens of Science, the focus within Science education had shifted away from students who were choosing to pursue post-compulsory Science. This report centres on the group of ‘post 16 Science students’. It explores their narratives, in a pertinent attempt to find out how their prior experiences and subject selection strategies may have guided them to the pursuit of Science at the post-compulsory phase. By exploring the attitudes, experiences and aims of these post 16 Science students, professionals could better support them towards achieving their goals, as well as develop practices that are better equipped to inspire other potential students to consider studying post 16 Science as a viable option.

### **Recent uptake & the ‘London effect’**

One of the long-term aims of updating the Science curriculum was to stimulate interest and the ‘wonder’ of students thus increasing the proportion of students who wished to study Science further and so increase the uptake of STEM subjects at university. Recruitment for STEM subjects was an important priority for government initiatives that came out at the time (Russell Group, 2009), as well as helping broaden students’ appreciation of the differing career options for scientists. More recent research by ASPIRES has suggested that interest in Science is not necessarily a limiting factor in uptake (DeWitt, Osborne, Archer, Dillon, Willis & Wong, 2013). This emphasises the need for a project, such as this, which explores how a range of identified and well-researched factors may come together to either promote or limit a student’s aspirations towards the Sciences.

At the age of 16, if students decide to stay in education, they can choose a variety of qualifications, including A-levels, vocational BTECS or apprenticeships. Academically able students tend to study at least three Advanced level (A-level) subjects, for a further two years. Following this students can choose to pursue higher education at university; only a minority choose STEM-related careers. The National Science Foundation report on Science and Engineering Education (Buccino, 1982) predicted a shortfall in the award of Science and Engineering undergraduate degrees in the 1990s. Similar concerns were raised in Europe (Gago, Ziman, Caro, Constantinou, Davies, Parchmann & Sjøberg, 2004) and the UK (HM Treasury, 2006). Since then, further studies (OECD, 2009;

Roberts, 2002; Sainsbury, 2007; The Royal Society, 2008) have monitored the uptake of Science, Technology, Engineering and Mathematics (STEM) subjects and raised their concern about the low post-compulsory uptake of these subjects.

The cross-national study by the Programme for International Student Assessment (PISA) described attitudes towards Science in Science Competencies for Tomorrow's World (OECD, 2007). It concluded that while many young people acknowledged the importance of Science, significantly fewer felt Science was important to them personally or that they wanted to pursue a Science-related career. Indeed, a more recent study, The Relevance of Science Education (ROSE) project showed similar conclusions, suggesting that school students, particularly those in developed countries such as the UK, do not feel very positive about their experiences of Science (Sjøberg & Schreiner, 2010). The ASPIRES project contradicts this demonstrating that despite students' positive interest and experience of school Science, this did not necessarily translate into Science-based career aspirations (DeWitt et al., 2013).

According to Bennett, Hampden-Thompson and Lubben (2011), between 1990-2010, the percentage of entries for Chemistry and Physics has fallen compared to entries from all post 16 subjects in England. For Chemistry, this has decreased from 6.8% to 5.2% in the last 20 years, and the percentage of students taking A-level Physics has dropped from 6.2% to 3.6%. This trend contradicts data from the Institute for Fiscal Studies which stated that higher percentages of students who have taken A-level Sciences in Year 13 in England between 2009 and 2010. They reported that 13% of all year 13 students studied Biology, 10% studied Chemistry, and 7% studied Physics (Jin, Muriel & Sibiet, 2011). This data shows that while many students choose to opt out of studying Science as soon as it becomes optional, this does not necessarily support the theory that students do not feel that Science education is relevant to them. Looking at the data in the context of percentages that study other subjects - where Maths is the most popular A-level choice with 16.5% of students studying it - the A-level Sciences all feature in the top ten most popular choices. Biology is the third most popular A-level subject; Chemistry is the sixth and Physics in the ninth position. Over a 20-year period, there had been a decline in uptake; however, studies analysing more recent data suggest a reversal of this trend in the short term. Data available through the Department for Education (Tingting, 2016) shows that between 2010 and 2014 there was an increased uptake in the percentage of student

entries in all three Sciences. For Biology, this had increased from 18.9 to 20.3%, for Chemistry this has followed a steeper growth going from 14.5 to 17.1% and for Physics from 10.1 to 11.9%.

The data from the Institute for Fiscal Studies also show that there are some gender differences in the uptake of Physics with four times as many males, proportionally, enrolled in Physics compared to females.

Subject	Male %	Female %
Biology	43.7%	56.3%
Chemistry	52.4%	47.6%
Physics	79.1%	20.9%

*Table 1 Comparison of males and females who choose each Science A-level*

The demographics of the students opting to study A-level Sciences show that there is a close link between the variation in uptake and the pathways that students take pre-16. In the early 2000s data indicated that 80% of students studied the equivalent of two GCSEs in Science with the remainder either studying a single Science or the equivalent of three Science GCSEs. Pupils who studied three separate Sciences at GCSE were more likely to take STEM subjects at A-level and were 76% more likely to get an A or B grade in A-level Science compared to those who took Double-Science (QCA, 2006; Russell Group, 2009). In 2001, 6-7% of students studied separate Sciences. According to the House of Commons Science and Technology Committee (2002), a third of these came from state schools. Less than one in three state schools offered separate Sciences, and the students who studied these were less likely to achieve A/A\* grades than their independent school counterparts. Independent schools accounted for a third of triple Science entries, and yet they gained over 50% of the A\* grades (Russell Group, 2009). This disparity raises questions about the relative differences in opportunities depending on the type of school attended. Together this shows that a student's gender, class and schooling had an impact regarding access to courses, attainment within them at GCSE, and uptake at A-level. From a social justice angle, these were all concerns that needed to be explored and addressed.

The past twenty years have seen increasingly rapid developments to identify and work towards addressing concerns regarding equity of access to Science-related opportunities and support. In 2008, any students reaching the expected attainment level at the age of 14 were given the non-statutory entitlement to study triple Science. As such access to the course improved with 52% of all schools offering triple Science in 2008, and 70% of all schools offering the course in 2010. While this was a positive step forwards there are still concerns raised The Sutton Trust's report 'Science shortfall' (Kirby & Cullinane, 2017) concerning the relevance of teacher qualifications where students in independent schools are more likely to have specialist Physics teachers than those in state schools (91% compared to 78%), as well as teachers with higher levels of qualifications. The report 'Changing the Subject' identifies a disparity in an individual's access to the courses where only 13% of Pupil Premium students<sup>1</sup> were taking Triple Science in 2013, compared to 30% of non-Pupil Premium students (Allen & Thompson, 2016). The report also suggests that the introduction of the English Baccalaureate has meant that more students are studying more Science subjects, so triple Science entries have increased from 17% of students in 2010 to 25% in 2013, as well as a 5% increase for entries for Pupil premium students. Although, this may be partially attributed to changes in government accountability measures in 2016 such as progress 8<sup>2</sup>. This project offers some important insights into how a range of factors, including those highlighted above, may affect the number of students who have chosen to study Science post 16.

Previous studies pointed towards a growing concern regarding the decreasing number of students choosing to study Sciences post 16 and the declining proportion studying Science-related degrees. Government reports indicated that this would have an adverse

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1 The term Pupil Premium was introduced in April 2011 and includes students who are looked after by the local authority, those who have been eligible for Free School Meals at any point in the last six years, as well as children whose parents are currently serving in the armed forces.

2 Progress 8 aims to capture the progress a pupil makes from the end of primary school to the end of key stage 4. It is a type of value-added measure, which means that pupils' results are compared to the progress of other pupils nationally with similar prior attainment. The calculation is based on pupils' performance across eight qualifications.

impact on the economy and would affect the standing of the United Kingdom as a centre where scientific knowledge is advanced (House of Commons, 2009; QCA, 2006; Russell Group, 2009;). Researchers such as Smith and Gorard (2011) who have raised pertinent questions regarding this phenomenon, asking whether there is a shortfall in STEM specialists or whether they are choosing not to work in their respective disciplines. They used large-scale secondary data and found that STEM graduates were unlikely to remain in the field after university and that those that did, continued as teachers. Their study suggests that either the workforce is unable to deal with the number of graduates of STEM subjects or that those graduating are not suitably qualified or perhaps that graduates make a choice not to work in the field. Given the above, perhaps it is not as simple as having more scientists graduating but also about which type of Sciences they choose to study and at which level.

Comparison of attainment across the country has highlighted what is known as the ‘London effect’ also referred to as the ‘London advantage’. Wyness (2011) used Income Deprivation Affecting Children Index (IDACI) figures as well as FSM and analysed the 2010 data for different Key Stages. She showed that attainment in London had improved in comparison to attainment in other areas for both FSM and non-FSM pupils. She found that the effect was small at KS1, but increased with age. At the time, she concluded that this effect related to what happens in London schools, rather than to pupil factors. The ‘London effect’ was further highlighted by Cook (2013) in Financial Times articles which showed that pupils in London scored more highly than the rest of England and that the difference was greatest for more disadvantaged schools and neighbourhoods. This attracted further research looking to analyse the trend more closely, as well as interest in identifying the causes for this trend in the hope that the effective strategies that had worked could be applied elsewhere (Baars, Bernardes, Elwick, Malortie, McAleavy, McInerney, Menzies & Riggall, 2014; Blanden, Greaves, Gregg, Macmillan, & Sibieta, 2015; Burgess, 2014; Greaves, Macmillan, & Sibieta, 2014; Hutchings, Greenwood, Hollingworth; Mansaray, Rose & Glass, 2012).

The ‘London effect’ is of interest to this study because it also identified a positive impact on post 16 outcomes which has yet to be fully explained. Inner London is unique as a context for this study because it’s high levels of attainment and progress at key stage 4

lead to better educational outcomes for students post 16. The study by The Institute for Fiscal Studies and The Institute of Education (Greaves et al., 2014) found that it is similar to other cities such as Manchester and Birmingham. They all have a higher level of deprivation (as measured by the proportion of students on free school meals) as well as a greater number of students from ethnic minorities compared to the rest of the country. It is also similar to these cities as they have all improved achievement at key stage 4 over a decade. In addition to this, they have closed the gap in attainment between students with free school meals and those without with regards to standard measures such as the proportion of students achieving five A\*-C, as well as those achieving 8 or more A\* to B grades (Burgess, 2014). In 2002, less than 25% of inner London students on FSM attained 5+ A\* to C's including English and Maths. By 2012 this had increased to 54%, while those in regions outside London were around 30-35% (Greaves et al., 2014). According to the authors, the 'London effect' for disadvantaged pupils appears to be sustained into post-16 outcomes, with disadvantaged students in inner London over 10% more likely to continue studying at key stage 5 than those in the rest of England, after accounting for differences in pupils, schools and performance. This is a unique aspect of inner London. Unlike other similar cities, higher achievement at key stage 4 has translated into higher levels of participation in the post-compulsory phase and so is likely to affect participation in higher education and so a student's later life chances (Greaves et al., 2014). While analysis of large-scale data was able to uncover this success, a qualitative study focussing on inner London may help to explore the reasons behind this sustained 'London effect'.

To date, there has been little agreement on what has contributed to these improvements in London Schools when compared to the rest of the country. Analysis of the statistics by researchers has shown that there is no single explanation for these improvements. Some studies had partially attributed this to enabling through resources, funding, teacher recruitment & school building quality. They also suggest that this may have been due to specific school improvement interventions such as the City Challenge programme (Hutchings et al., 2012), the Academies programme, Teach First and improved support from local authorities (Baars et al., 2014). Others have questioned whether these could have been the primary driving force behind these improvements. They demonstrate that improvements had begun in attainment in primary schools in the mid-90s. Data shows that, in 1997, 47% of poorer students made expected levels of progress in English at 11



years old, but this had grown to 75% in 2008. Therefore, they suggest, the ‘London effect’ was likely to be as a result of increased prior attainment in the primary phase of schooling (Blanden et al., 2015; Greaves et al., 2014). Although Blanden et al. (2015) also argue that a difference in the ethnic mix of students could account for one-sixth of the improvement. They show that white British students have the lowest progress measure and that they form 35% of students in the London schools, but 85% of the students in the rest of the country. The researchers suggest that the remaining differences may be due to gradual improvements in school quality as well as an increased focus on performance and attainment by regulation through Ofsted, the national strategy and floor standards. The above studies have explored this using large-scale quantitative data. These studies have been useful in identifying particular factors that could have influenced students’ attainment at age 16. However, they do not necessarily explain how they have led to increased participation post-16. This indicates a need to understand the ‘London effect’ using qualitative tools exploring student perspectives and experiences in light of these suggested influences. Understanding the positive experiences of students within this unique context would help to target efforts that could allow other cities to benefit from their experiences and target efforts elsewhere to improve upward social mobility (Gorard, 2012).

## Purpose of Study

In the UK education system, most students study a similar curriculum, give or take some minor variation, up until the end of key stage 3, aged 13/14. At that point, students have a compulsory core of subjects and can choose the remainder from a limited range. Their preferred combination forms the basis of their study for their next two years of compulsory schooling and these lead up to formal qualifications called General Certificates of Secondary Education (GCSEs). Science is a compulsory subject for all students, at this stage, although the high attainers usually have a choice of courses. At least 54% of students in UK schools (Jin et al., 2011) have a range of pathways where they either study a double award in Science (equivalent to two GCSEs) or separate Sciences in Biology, Chemistry and Physics (equivalent to three GCSEs). Those who

have passed their GCSEs and have met the minimum entry requirements can choose to study A-levels in the Sciences, and may then pursue Science-related careers.

The first stage of opting to study Sciences at A-level is meeting the entry requirements at GCSE to enable students to make that choice. Much research has focused on motivation and interest, as well as self-regulated learning, supporting the notion that they are significant factors in the attainment of students (Schunk, 1991; Thompson & Musket, 2005; Tumen, Shulruf, & Hattie, 2008; Zimmerman, Bandura, & Martinez-Pons, 1992). Another key contributor is students' interest in subjects. There has been significant research highlighting the link between students' self-concept (belief in their academic ability) and their interest in the subject (Enman & Lupart, 2000; Häussler & Hoffmann, 2000; OECD, 2007). Other studies have suggested that both their attitudes and interests help inform student decisions for pursuing further courses and when making career choices (Cleaves, 2005; Hill, Atwater & Wiggins, 1995; Morgan, Isaac & Sansone, 2001; Simpson & Steve Oliver, 1990; Wyer, 2003).

This study aims to build on the knowledge base from the above studies and through exploring the experiences of inner London students who have decided to pursue at least one A-level in Science and to gain some insight into the factors that have affected their decision-making. The section above highlighted the need for the UK to monitor and increase the uptake of students choosing to study A-level Sciences, as was the background for the changes to the GCSE provision for all students. Many of the reforms in the past ten years have been about catering for the scientific literacy of the majority of students in the UK who do not go on to further study of Science; whereas there is little research on the impact on those who would like to continue studying the Sciences. Gaining insight into the surrounding factors and student decision-making strategies for A-level is key to understanding how to increase uptake of the Sciences at A-level. This study focuses on the minority of students that choose to continue studying Science post 16. It aims to highlight their narratives, their approaches to decision-making and their personal experience of the factors that led them to the decision to study at least one A-level in Science further.

This research aims to look at how students engage in a critical decision regarding their educational and future careers. For most students, any decision surrounding their GCSE

subject courses does not necessarily limit their study of future STEM subjects. At A-level, when students opt not to study certain subjects they limit their choice of degrees regarding higher education. For example, a student who chooses not to study Chemistry at A-level will not meet the entry requirements to study medicine or pharmacy at university. Similarly, a student who chooses not to study mathematics cannot go on to study engineering further. Given the long-term consequences of the decision, this stage is the focus of this study.

There has been plenty of international research on areas of interest regarding subject preferences and aspirations, and this is discussed further in the literature review. There have also been large-scale studies such as TIMSS and PISA based on secondary data analysis, and while they are important and valuable, they are not complete alone. Recently more studies have begun to look at this qualitatively using the students' own experiences (Bennett et al., 2011; DeWitt et al., 2013; Lyons & Quinn, 2010). The ASPIRES project (DeWitt et al., 2013) has looked at the broad range of factors that affect students' uptake of Sciences at the post-compulsory stage. The factors identified have included students' experience of Science in school, structural aspects of schools, students' characteristics, including their age, gender and socioeconomic background. However, there has been limited literature focusing on A-level Science students in inner London and on how the combination of these structural, social and individual factors work together in this context to affect a student's choice to study Science. The above research highlights the need for a study that will add to and build on the established research within this field. The research questions below will allow for the identification of factors that have affected students within inner London and allow an exploration of how these factors fit together when students' make their overall decisions. Together this will add to the growing knowledge base in the field and will help educators to plan suitable support and guidance for future generations given the experiences of those who have chosen Science, within this unique context.

### Summary of research questions

1. Which factors influence students A-level subject choices and how are they linked?
2. Which trajectories did A-level Science students use to decide which A-level subjects to choose?

3. How are the factors that influence A-level subject choices linked to the trajectories followed?

## Literature Review

When making their decisions about A-level subject choices and their careers, students approach the decision-making process in diverse ways and take into account a wide range of personal, social and structural factors. The topic of STEM uptake at post 16 is important to educators, industry professionals, policymakers and society, and as such this area has attracted a wide range of research. By reading previous studies and engaging with established research in the field a deeper knowledge of STEM subject choices was gained. This was used to underpin and contextualise this research project within the field and identify where a unique contribution to knowledge could be made.

This literature review is in two distinct sections. The first is an exploration of the factors that have some effect on students' A-level subject choices, based on the findings from past studies, and the second is an introduction to the choice process and how this study aims to explore it through the theoretical framework developed. The literature review has been structured to take into consideration current research in the Science education field and seeks to summarise factors that have been identified by other researchers as affecting student uptake of the Sciences post 16. An understanding of these factors has fed into the structure of the research, and the analysis of the data gathered and formed the basis for the questionnaire that was produced and distributed amongst the sample student group. Several frameworks used in studies of STEM choices are explored, and the relevance of their use to gain an understanding into how students make decisions at the post 16 stage of their study are discussed and the theoretical framework used in this study is shaped and explained. This together with knowledge of the potential factors that influence students' choices, allows for a greater in-depth analysis of the responses to the interview section of the results.

### Factors that affect students' decision-making

There is a range of individual factors that have been identified by researchers as being directly linked to student uptake of the Science subjects. In this section, factors are grouped and discussed under seven headings. These headings were partially informed by Tripney et al's (2010) review of the UK literature on the area, as well as the study conducted by Bennett et al. (2011). They form an important cross-section of research areas that have been shown to have an impact on the post-compulsory study of Science. These headings are 'attitude to Science', 'attainment, self-efficacy & self-concept', 'career aspirations', 'socioeconomic background', 'gender', 'school-related factors' and 'family & society'.

### **Attitudes to Science**

While many studies focus on students' attitudes towards Science, there is some ambiguity in the meaning of the term 'attitude to Science'. Indeed, a systematic review on Interest, Motivation and attitude towards Science highlights that of the 228 peer-reviewed research articles selected, only 136 provided explicit definitions for the constructs (Potvin & Hasni, 2014). In addition to this, the aforementioned authors focus their review on seeing how attitudes, motivation and interest vary between kindergarten and school. This thesis focuses primarily on the links to uptake at the post 16 phase. While there were 228 articles between 2000-2012 found by the authors it was rare to find articles that focussed on how attitude linked to uptake. Of these articles, researchers such as Lindahl (2007) and Osborne et al. (2003) suggest that students with a positive attitude to Science are predisposed to continue studying it. Others including Lyons (2006), Bennett & Hogarth (2009) and Jenkins & Nelson (2005) do not find such an association. This section looks at some of the established research within the area exploring the links between attitudes and uptake but not assuming that there is a direct one.

It is important to begin by identifying what is meant by the term attitude in this study. There are several variations that researchers have used which serve as a measure for attitudes. These include attitudes (Hill & Wiggins, 1995; Hutchinson & Bentley, 2011; Linahl, 2007), disposition (Bennett & Hogarth, 2009), interest (Häussler, & Hoffmann, 2000; Logan & Skamp, 2013; Morgan, Isaac & Sansone, 2001; Yang, 2010), enjoyment, (Breakwell & Beardsell, 1992; Matthew & Pepper, 2005) perception (Hemsley-Brown,

1999; Korpershoek, Kuyper, Bosker, & van der Werf, 2013) and importance (Jenkins & Nelson, 2005). Attitude to Science could be in relation to it as a 'school subject in the compulsory phase of a student's education' or 'Science in society' which will affect an individual in their day to day lives or 'Science as a career' from which a student may forge their professional life. It is evident from the literature that a useful definition encompasses all of these ideas and this is evident from the variety of measurements and tools that can be used to reflect student attitudes. These range from various attitude scales where students agree or disagree with statements, to lists of topics which students tick if they were interested in studying them, to open interviews discussing the topic and student preferences. According to Wright (2006), a significant proportion of the research that has gone into student attitudes to Science focuses on their attitudes to school Science as opposed to further study. While attitudes to school Science are important for all students, they have to interact with an increasingly scientific society and so attitude to Science should encompass both. In this study the PISA 2006 definition (OECD, 2006) of which includes 'curiosity' and 'willingness' is used to understand attitude. As such a positive attitude displaying interest in Science is one where students indicate curiosity in Science and Science-related issues and endeavours, as well as demonstrate a willingness to acquire additional scientific knowledge and skills and have an ongoing interest in Science, including consideration of Science-related careers. It is important to work towards a sound understanding of which attitudes are specific to promote the further study of Science for the minority of students who will potentially pursue a Science-related career, and this is the focus of this study.

The ROSE study was completed in 2010 (Sjøberg & Schreiner) and found that compared to other school subjects, Science is seen as less interesting and relevant to students' everyday lives. Some studies show that student interest in Science, at the age of 10, is relatively high with little gender difference, and that a decline in attitudes develops alongside gender differences as children get older (Murphy & Beggs, 2005; The Royal Society, 2008). The study by Osborne and Collins (2001) as well as that of Bennett and Hogarth (2009) found that although students had the least positive attitude towards Physics, it was Chemistry that declined the most and that it did so between the ages of 11-14. As such, talking to students to explore the link between interest and uptake is pertinent. Given the changes to the content of the curriculum and the increased focus on making it relevant to students at GCSE, this study would be ideal with regard to exploring

whether there were aspects of the curriculum itself that particularly interested students, or did not.

A large number of studies show that students' learning experiences in the classroom can affect their attitude and consequently may affect uptake at A-level, particularly if students want to pursue a Science-related career (Bennett & Hogarth, 2009; Osborne, Simon & Tytler, 2009; Stokking, 2000). Evidence for this lies in a multi-national study by Lyons (2006b) which suggests that students attitudes and learning improved when content taught is relevant, interactive and 'not too difficult'. However, another study by Gorard and See (2009) suggests that the importance of links between attitude to Science and Science uptake are exaggerated, as in some studies positive attitudes do not correlate with the uptake of the Sciences. Furthermore, a study by Lyons (2006a) in which surveys and interviews were carried out with a range of students in South Wales who had just made their decisions about subject choices found that the students' descriptions of school Science did not differ between those who wanted to continue studying it and those who did not. The study included both students who had chosen to pursue the Physical Sciences, as well as those who had not. Both groups of students tended to describe a decontextualised curriculum, with themselves as passive learners. This finding is supported by DeWitt et al. (2013) who also suggested that young people's aspirations remained consistent throughout the ages studied, (10 to 14 years old). This claim is also further supported by a longitudinal study of 70 students in Sweden that followed students between the ages of 12 to 16 (Lindahl, 2007). Lindahl found that students had formed their career aspirations and interest in Science by the time they had reached the age of 13. Although the latter study took place in Sweden, both studies suggest that the timing of career aspiration formation is critical and needs to be taken into account as they may affect subject choices post 16. They also suggest that early secondary learning experiences may have more of an impact in forming attitudes and career aspirations than later secondary learning experiences. Given that inner London has been shown to be an area where there are higher levels of participation in the post-compulsory phase, it is possible that these findings may not be transferable to the students within this area and so a qualitative study focusing on these students is needed.

The above studies were similar in that they chose to focus on the majority of students as a data set examining their attitudes towards a subject that is compulsory for all (pre-16).

This study differs as it focused on the attitudes of those students who had chosen to study at least one Science A-level and looks at the perceptions that led them to choose these. This retrospective analysis has several benefits since it focused on students who had already decided to pursue further Science studies. Furthermore, the nature of the research through the use of interviews alongside surveys allowed a richer exploration of the identified trends, including the increased levels of participation at KS5 as part of the 'London effect'. Rather than interpreting the quantitative data set and attempting to explain the patterns, this study included both quantitative and qualitative data from the participating students thus providing a unique insight which coupled with the chosen choice framework can contribute to our understanding within the field.

Earlier research by Deci & Ryan (1985) has traditionally argued that intrinsic motivation is strongly related to student achievement and career choice and that students who are intrinsically motivated to learn mathematics or Physics find the subject to be interesting and enjoyable. Several studies have looked at whether a student's academic achievement can impact their attitude to Science. Students who do not achieve as well in the Sciences do not meet the entry requirements for the further study of it, and so this has the potential to impact uptake. Improving a student's academic achievement and perhaps their attitude of Science, if there is a causal relationship, could, in turn, affect their uptake of Science. Meta-Analysis of 18 studies written between 1970 and 1991 found moderately positive correlations between attitude and achievement (Weinburgh, 1995). The Third International Mathematics and Science Study (TIMSS) (Beaton, 1996) also found a consistently positive correlation between them. This finding suggests that those with more positive attitudes towards Science are also more likely to be those students who have high achievement in the Sciences. The more recent TIMSS Advanced study (Stephens, Landeros, Perkins, & Tang, 2016) looked at the attitude and achievement of students across nine countries (not including the UK) and found a strong relationship between excelling at and liking a subject. They found that students on Physics courses valued Physics (83%) and were positive about their teaching, but they were less positive about learning Physics. Of the students sampled there were 26% who did not like learning Physics, 51% did like learning it, and 23% liked learning Physics very much. In addition to this, when data was analysed with regards to attainment the 23% who liked learning Physics very much achieved more than 100 points higher than the 26% who did not like learning Physics. This finding is apparently contradicted by earlier research from the



TIMSS study in Europe (Osborne & Dillon, 2008) suggesting that the higher the average student achievement, the less positive their attitude towards Science. This trend is further contradicted by the ROSE project (Turner & Peck, 2009) where a negative correlation was found between interest and the United Nations comparative national index of human development. On the surface, this raises questions about whether the attitudes of high achievers have changed with time and whether they hold for students in the UK, inner London, context. The TIMSS 2015 data looks at achievement within a subject and enjoying learning about it, whereas previous studies have looked at average attainment. These apparent contradictions highlight the need to focus on the complexity behind the links between attitudes, achievement and uptake, as well as to look for the significance of context on these links. Given that large-scale data has highlighted that higher attainment at key stage 4 in inner London schools has led to higher participation in the post-compulsory phase, qualitative research tools are now needed to gain insight into the nature of these links with a focus on this particular geographical area.

Participation and engagement with Science in comparison to other subjects have been the focus of several studies. According to many studies, when compared to other school subjects, Science does not engage young people (Jenkins & Nelson, 2005; Lyons, 2006b; Osborne & Collins, 2001; Sjøberg, 2000). A study in 2005 (Jenkins & Nelson) looked at results of a questionnaire-based project looking at the Relevance of Science Education (ROSE). In this study 1277 14 to 15-year-old students studying in England shared their perceptions of their school Science education, as well as their choice of careers and what they would most like to learn about in their Science lessons. One of the main findings was that students recognised the importance of Science and indicated that it is a subject that everyone should learn at school but yet did not feel it was ‘for them’. This finding is significant because students who did not feel it was for them were less likely to opt to study it at the post-compulsory phase or build related career aspirations. Many earlier studies based on student attitudes to Science (Beaton, 1996; Jenkins & Nelson, 2005; Osborne, Driver & Simon, 1998; Ramsden, 1997; Weinburgh, 1995) consisted of predefined categories and closed questions. While their design allowed for facilitating statistical data and looking for trends, they offered limited insight into the contextual meanings behind student responses. This study used open questions within the interviews to minimise this limitation and offer a deeper understanding of the views shared by students. Open questions provide far more insight into why students have made their

particular choice. In addition to this, almost all the studies mentioned above-sampled students who were taught the old curriculum before the 2006 changes that aimed to make the Science curriculum in England more engaging and relevant for all students. This study, alongside others, was able to look at whether these findings are still valid in light of these changes. Since a significant period has passed since the implementation of these changes, student engagement may have increased in light of them.

Of the 216 articles that looked at attitudes of students to Science between 2000-2012, only 16 used interviews as a research tool, with the majority of the remainder (189 articles) relying on questionnaires (Potvin & Hasni, 2014). This would suggest that the research area may benefit from further qualitative research in this field. Analysing attitudes towards Science and the impact this has on uptake is vital for stakeholders. The absence of a causal pattern raises questions about whether resource allocation is efficient and suggests that the time and support that has been put in place to improve attitudes in an attempt to increase uptake may be better placed elsewhere. These findings would suggest that while attitude to Science is important, it may not have an impact on subject uptake. Within this study, student responses were analysed for displays of interest in a subject, as well as whether this had an impact on uptake of the subject. The studies above have also given conflicting information as to when the critical ages are for students when making decisions with regards to both their future studies and career. This study aimed to address some of these inconsistencies by determining when students said their interests in the subject or career had begun to develop. This information would be beneficial to practitioners, as it would help them to look at the strategies used by students in the sample as well as perhaps gain some insight into what has been ineffective in developing student interests, and more importantly, why. It may also shed some insight into why students with apparently high levels of interest may not have these translate into the uptake of the subject at A-level.

### **Attainment, Self-concept & Self-efficacy**

The three variables attainment, self-concept and self-efficacy, have been grouped as they relate to an individual's academic background. There is conflicting evidence about

whether there is a direct link between attainment and take up of Science. Studies have pointed towards attainment, self-concept and self-efficacy (a student's belief in their ability to succeed) being important factors (Breakwell & Beardsell, 1992; Oliver & Simpson, 1988). In this study self-concept is referred to as a student's 'belief in their own academic abilities' and self-efficacy is defined as a 'students' belief both in whether they can handle tasks and overcome difficulties' (pg. 46, OECD, 2011).

The role of attainment in subject selection at the UK post-compulsory phase is important. Once students have finished their GCSE course, students can choose the subjects they wish to pursue at A-level and selection of the Sciences is limited by entry requirements that restrict choices for lower attaining students. Minimum requirements range from between A-C in the Sciences, with some sixth forms adding minimum attainment requirements in English Language and Mathematics too. These requirements restrict the choice for students who have low prior attainment (Smyth & Hannan, 2006). Gill & Bell (2013) used the National Pupil Database and a multilevel modelling technique to identify factors that led to a greater uptake of A-level Physics. Their research found that better attainment in the Sciences and maths at the age of 16 (usually at GCSE) increased uptake of A-level for both genders. Based on pupils entering A-levels in 2007, those who achieve an A\* in GCSE Physics are ten times more likely to progress to A-level Physics than students who achieve a B (Powell, 2010; Stephens et al., 2016). This would suggest that high attainment may well be a motivator for those who did exceptionally well. However, it is also possible that the converse of this where students who are motivated to study Physics further and are also motivated to study and do better academically at it. While the correlation has been found, it is important that the nature of link is explored via qualitative means. Another possible effect of high attaining students choosing the Sciences could be that the subject is seen to be chosen by students who do well (Osborne, Simon & Collins, 2003). This observation may then reinforce the notion that only intelligent people study Science subjects because Science is complicated. Bandura (1977) argues that students determine their self-efficacy by considering their positive and negative experiences in a given task and whether a person feels competent while doing it. In addition to this they are also influenced through watching other people perform tasks and comparing their competence against others. As such, this may negatively impact their self-efficacy. Understanding why students have a poor self-concept of particular subjects

as opposed to others can be useful in encouraging uptake by addressing the issues that have caused these perceptions.

Initially, several studies suggested that students' perceptions of the difficulty of a subject played a role in their decision-making (Cheng, Payne, Witherspoon & Britain, 1995; Havard, 1996). Osborne and Collins (2001) explored student attitudes to Science through focus group interviews with 144 students and found that both Science and non-Science students referred to aspects of Science as being difficult to understand. Furthermore, a study by Coe, Searle, Barmby, Jones and Higgins (2008) confirms that amongst A-level subjects, it is hardest to achieve the highest grades in the Sciences, modern foreign languages and mathematics. One factor that affects self-efficacy levels as identified by Bandura (1977) is physiological states. If a student experiences negative emotions such as anxiety as a result of this perceived difficulty this could negatively impact their self-efficacy. One of the aims of this study will be to ascertain how self-concept and self-efficacy play a role in student's post-compulsory subject choices. Students may be more likely to select subjects they are likely to succeed in or feel more confident about. This echoes findings from a value-added analysis by Fitz-Gibbon (1999) that suggested that it may be harder to get higher grades in Sciences compared to most other subjects. The study suggests that students may decide to take subjects where they are more likely to attain higher grades and so carry less risk. Conversely, another study by Lyons (2006a) suggests that despite this the perceived relative difficulty of studying Physics and Chemistry and their strategic value for a student's future career gave the subjects a certain level of prestige for students.

As this study was retrospective the students who were studying on the courses were likely to have already met the minimum entry requirements for their chosen A-level subjects. This study explored what students' perceptions of their abilities were in Science. It also explored the role of self-efficacy in choices between the Science options and whether students used these factors to make choices between the A-level Science subjects and alternative non-Science based subjects. In this instance, open-ended interview questions gave students an opportunity to reflect on their self-perceptions and efficacy, as they talked through their retrospective selections during the interview.

## Career aspirations

Many students choose to study Science post 16 if they aspire to pursue Science careers and need to study Science to gain entry into their preferred course. The Russell Group of universities includes each of the Science A-levels in their list of facilitating subjects (Russell Group, 2016). A facilitating subject is one that when studied at A-level leaves a broad range of options for university study.

A longitudinal study, ASPIRES 1, by Archer, DeWitt & Wong (2014) looked at how students' ideas progressed through age 10 to 14 and concluded that the majority of students in the study had decided not to pursue a career in Science before entering secondary school. However, ASPIRES 1 study does not look at whether this changes as students' approach their decision-making point at the end of compulsory schooling. Although ASPIRES 2 does focus on students aspirations over time, the data relating to 15-18 year-olds published to date has been limited to selection for triple Science courses, careers education and work experience provision. Looking at how a student's aspirations over time have translated into uptake statistics is important. This is because a students' understanding of different subjects and careers may develop after the age of 14, with the imminent need to make a decision.

Further evidence for this lies in a survey of 1,141 Science, Engineering, and Technology (SET) practitioners' reasons for pursuing scientific careers by the Office of Public Management (Yacoub, 2006). The study found that the major factor in a student's decision to pursue Science was their life experiences before the age of 14, and explains why researchers leading ASPIRES phase 1 may have focused on this period initially. However, the study showed that 28% of the adults had considered a Science-related career by the age of 11, while 35% had considered this between the ages of 12-14. This finding implies that for the remaining third of practitioners their decision to pursue Science began after the age of 14 and would suggest that there is some merit in encouraging students to engage with careers advice and fairs, as well as work experience placements after the age of 14.

As part of the five-year longitudinal study, ASPIRES, DeWitt et al. (2013), determined how young people's aspirations developed over the ages of 10 to 14 years old and explored the factors that encourage a young person towards aspiring to a Science-related career. They collected data at three-time points during this age period and in total included over 19000 online surveys, as well as interviews with 83 students and 65 parents. The study suggested that young people's aspirations remained consistent throughout the ages studied. The authors also concluded that despite students reporting high interest in Science, only 15% aspired to become a scientist. Perhaps it would have been worthwhile unpicking what these students believed scientists did or reasons behind why they did not want to be one. The authors' data shows that despite only 15% aspiring to become a scientist 35% of students agreed they would like to go into the medical field and 25% wanted to become engineers. This finding would suggest that students were interested in Science-related careers, and actually, represents a positive reflection of aspirations within the Sciences. The implied suggestion from the researchers here is that being a scientist is mutually exclusive to working with Science, and perhaps this is flawed. Perhaps adding another layer to this question would allow students to rank each of their occupational choices so that there could be a comparison of career preferences. In addition to this by the end of year 9, 42% of the sample said they were interested in studying more Science in the future, although, given the wording of the statement and the compulsory teaching of Science up until age 16, this could just have meant up until the age of 16. It would be beneficial to see within ASPIRES 2 phase whether the students interviewed students how students post 16 decisions evolved and to see whether their aspirations changed closer to the decision-making period.

Furthermore, a recent study by the Wellcome Trust Monitor (Clemence, Gilby, Shah, Swiecicka, Warren, Smith, Johnson, Nissen, Hoolahan & D'Souza, 2013) reports that less than two out of three young people (aged 14-18) say they know little or nothing about STEM careers. This finding highlights the need for intervention at this stage to assist students in making a more educated decision with regards to their career aspirations. This adds further weight to the findings from the ROSE study which suggests that students consider making their career choices at a time when their motivation in Science subjects is reducing, and their perceptions of what for many are largely invisible careers are very hazy (Munro & Elsom, 2000). Given how important career aspirations are, an exploratory study of how students form their ideas about the future was carried out by the DCSF and

concluded that while year seven students have some idea of what they want to do, they were not sure how to get there (Atherton, Cymbir, Roberts, Page & Remedios, 2009). Although this implies a significant problem, young people have increased access to such information via the world wide web, and so perhaps is not an issue given advances in technology. Lindahl's (2007) longitudinal study of students between the ages of 12 to 16 found that students had formed their career aspirations and interest in Science by the time they had reached the age of 13. Taking this at face value would mean that encouraging older children in Science becomes progressively harder. This link appears to be further strengthened by a longitudinal US study (Tai, Liu, Maltese and Fan, 2006) which reiterated the connection between the early formation of aspirations for Science-based careers and a tendency to study post-compulsory Science. The latter research began with surveys of 8<sup>th</sup> graders initially in 1988 then in 1990, 1992, 1994 and 2000. While this provides data over a significant time period the transferability of that data and the relatability of it to inner London students is questionable for two main reasons. The first of these is the time period over which the research took place and as an effect of this the significant changes in society that may affect the availability of careers and our understanding of them. Secondly, both studies were based in different countries with different social, political and economic contexts.

Within the study, it was important to find out whether students have career aspirations, as well as if they are Science-related and when and how they began to form. The above studies suggest that for a significant proportion of GCSE level students, career interventions including option evenings and taster days may come too late. The study explores whether these events are targeting students at an optimum time and what kind of impact or perceived usefulness they may have on subject choices from a student's perspective during the selection process. In doing so, it will build on work done by ASPIRES 2 in looking at careers guidance and work experience and seeing how it feeds into the selection process, rather than just how students experienced the support itself. ASPIRES phase 2 surveyed of 13421 Year 11 students and summarised that less than two-thirds of these had received careers education, with varying quality of provision and access. They also concluded that provision was not just patchy but patterned with particular groups including girls, minority ethnic groups, working class & lower attainment and school leavers less likely to access careers support. They found that while

students who had high aspirations in Science were more likely to have careers education they were also those who were less likely to have had work experience.

One of the key aims of this study was to ascertain the trajectories students followed when deciding which subjects to study which provides insight into the optimal engagement point for the majority of students in determining a future Science career. The above studies show there is much contention within the community of Science educators as to how and when firm career aspirations develop. The studies also raise questions as to where students get their understanding of Science careers from, and whether key influencers such as subject teachers and parents communicate the variety of Science careers and career pathways available.

### **Socioeconomic background**

Within the Inner London setting, the achievement gap between students who are disadvantaged and those who are not has been narrowing over the past ten years leading to higher rates of participation in the post-16 study compared to the rest of England. Disadvantaged students are doing better in London, than elsewhere and they are more likely to stay in education after the age of 16 (Greaves et al., 2014). The Socioeconomic background of students has been shown to be a predicting factor when determining what affects the educational journey of students. Most of these factors have been shown to affect students through access to opportunities and resources. Understanding how socioeconomic factors may have changed a student's life chances and looking at the opportunities that may have been instrumental in closing this gap will be useful in understanding what statistical analysis has uncovered as the 'London effect'.

Over the years there have been various attempts to measure a student's socioeconomic status. These have included students eligibility for free school meals (FSM), mothers occupation, parents education, family income, home ownership, number of books in the house, residential postcodes and size of the family. In the UK the multilevel measure of deprivation is the Income Deprivation Affecting Children Index (IDACI) which includes whether there is a household car, lone parents, adults who have no qualifications and



unemployment rates. The IDACI was the measure used by Wyness (2011) in analysing the 'London Effect'.

Researchers such as Croll (2008) argue that although those that are not disadvantaged do better academically, those amongst the disadvantaged that do well academically and are ambitious can do just as well in terms of career outcomes. This would suggest that inequality can be addressed by targeted efforts to improve attainment and then aspiration of those that are disadvantaged. However, the reasons for the gap in attainment are fundamental. In the simplest possible sense inequalities based on access to material resources have an impact on educational success. Barriers relating to spending can limit a student's access to basics such as school uniform, books, internet access and space to study at home (Archer, Halsall, Hollingworth & Mendick, 2005). Above this are limitations due to access to extra support to widen the breadth of learning through visits that enhance a student's cultural capital, including exhibitions, museums, libraries and tuition services (Reay, 2004). Foskett & Hemsley-Brown (2001), Mensah & Kiernan (2010) found that even more significant than economic resources were socio-cultural factors like the age of the parents, the mother's education and the student's local area. While there is little that can be done about the age of a parent or their previous educational levels or home location, there have been several initiatives in the UK that target material inequalities. These have included free access to museums and galleries, availability of public libraries, access to technology in schools, free transport for young children and financial support for buying school uniforms. There are also many programmes run by institutions including universities targeting disadvantaged students with the aim of mentoring them and raising aspirations. With access to a wide range of museums, galleries, public transport, universities and the diversity of people within London it is possible that these strategies may have been effective in removing some of these barriers and as such contributed to the 'London Effect'.

Gorard and See (2009) used large-scale official datasets to show the stratification of participation and attainment in Science by socioeconomic status (SES). They also found that students from poorer families are less likely to take Sciences at post-16 than many other subjects and that even those who do take Sciences are less likely to obtain grades high enough to encourage further study of the subject. In the same study, the difference in uptake post 18 is determined by students' prior attainment, which has been shown to

be different for students from various backgrounds (Gorard and See 2009). Another report by the Institute for Fiscal Studies (Jin et al., 2011) found that ‘triple Science exams, were disproportionately taken by students from less deprived backgrounds, with pupils eligible for free school meals less than half as likely to take separate Science exams compared to their less deprived peers.’ (ibid: 17). ASPIRES phase two study also confirms this finding stating that socially disadvantaged students were two and half times less likely to study triple Science and that 61% of the surveyed students felt that the schools had made the choices for them (Archer, Moote, Francis, DeWitt & Yeomans, 2016). This difference in pathways impacts student life chances, particularly when earlier research found that pupils who studied triple Science were more likely to study STEM subjects at A-level and 76% more likely to gain a higher grade within it (QCA, 2006). While these studies identified the correlation, they do not account for why this difference occurs and the subtleties behind why this difference is not as significant within the inner London area. Socioeconomic factors can be due to a wide range of subfactors, which presents a challenge for research in this field. While this study touches upon socioeconomic factors, it seeks to analyse it through its impact on related factors which are more explicit from a student perspective, including family and school opportunities.

Bourdieu (1986) discussed how levels of educational participation are often reproduced through generations, hence reproducing inequalities and contributing to the perpetuation of social class boundaries. An example of this is a finding from an analysis of PISA data of 12000 students carried out by Hampden-Thompson and Bennett (2013) who found that the longer the parents have been educated and the higher their occupational status, the more likely it was for a student to consider a Science career. They also found that students were more likely to see themselves in a career involving Science if one or more of their parents were already in a Science-related career. In turn, this would mean that family members with an active or previous involvement in a Science-related career play a role in affecting younger members when pursuing their educational journey, and socioeconomically advantaged families with higher occupational status and education are more likely to have children who study Science. Archer et al. (2014) refer to this combination of characteristics as ‘Science capital’, and attribute this trend to a sense of belonging to Science. Students may feel their goals would be more attainable and realistic if a member of their close family followed a STEM career, or was educated to a high enough level.

The research suggests that there is a wide variety of ways that socioeconomic backgrounds can affect a student's preferences and choices and that, individual students have varying levels of Science capital which can potentially serve to encourage them to pursue Science further. As well as experiences and constructs surrounding educational and social background and ethnicity, the nature of relationships with adults surrounding students is important. Within this study, there is a discussion of the experiences and people who have affected a student's subject choices and the effect they have had, from a student's perspective. Also, given the unique context of the study in an inner London setting, the study will focus on other aspects of Science capital identified by students, perhaps unique to inner London, which may have helped to narrow the gap between advantaged and disadvantaged, regarding both aspirations and attainment. The studies above have accounted for some of these contributing factors. However, a study of this nature focusing on just Science students, within inner London, has the potential to encompass a wider range of factors within chosen trajectories rather than an emphasis on a select few. It should also help shed light on how we can address some of the inequality due to these socioeconomic factors so that those who have less can get more support. This can be done with a broader understanding of how these factors can interplay and affect the decision-making process.

## Gender

Participation in Science has differed between the two genders historically. In England, male students are more likely to take up Physics than female students, but similar proportions of each gender take up Chemistry (Murphy & Whitelegg, 2006; The Royal Society; 2008; Vidal Rodeiro, 2007). The Institute for Fiscal Studies (Jin et al., 2011) found variation in the uptake of individual Science at GCSEs. They found that separate Sciences are taken by a greater percentage of boys (55%) than girls (45%), while girls are more likely than boys to study Art and modern foreign languages. Although some of these variations were relatively small, there was a significant difference in the percentages representing male and female take-up of Physics.

Another researcher, Stewart (1998), surveyed 128 A-level Physics students looking at characteristics that encouraged them to opt to study Physics and to gain some

understanding of the underrepresentation of female Physics students. She found that although outnumbered by 35:93, the girls in the sample were more likely to have attained higher grades at GCSE and were more likely to identify Physics as their favourite subject and value the contextual aspects of the course, compared to the boys who were more likely to want more mathematical elements. Another key difference related in the study was that of further career pathways, with girls more likely to want to pursue the study of medicine, and boys more likely to want to study engineering or computing. Findings from other studies also point out gendered differences in preferences, with girls more likely to aspire to health-related courses and boys more likely to be drawn towards technology and Physics (Bennett & Hogarth, 2009; Jenkins & Nelson, 2005; Lyons & Quinn, 2010). A study by Haste (2004) has suggested that students could be grouped by personality types that are not attracted to Science. He identifies a group of male students who are fascinated by technology - 'techno-investors' – and another predominately female group which is 'alienated from Science'. It is apparent that this area has attracted research from two angles. One of which is to help increase uptake overall and the other is from a social justice perspective where both genders should have equal opportunities and support to choose to pursue any careers within the Sciences. Research has since looked to unpick how these differences emerge.

Initially looking at differences in uptake was useful in highlighting the problem of disparity between the genders, however research is emerging which looks beyond differences in uptake of each of the disciplines; it looks deeper into the themes and topics within the disciplines. For example, gendered differences in Biology show that boys prefer learning about cells and extinct species whereas girls are more likely to prefer botany and mycology (Prokop, Prokop, & Tunnicliffe, 2007). Yang (2010) went further and showed through interviews with twenty-four students that those students who initially identified as least interested in Science and technology were actually very interested in aspects of it. Another study looking at Physics found that different learning activities within the lesson could also have an effect on students attitudes to learning (Owen, Dickson, Stanisstreet, & Boyes, 2008). The researchers share that where girls showed a preference for teamwork and written activities, boys showed a preference for doing experiments and performing calculus. The research suggests that it is not just what is taught that makes a difference in preferences but also how it is taught.

The structure of the UK educational system is structurally diverse, and these differences can show variation in the uptake of the Sciences. For example, the difference between attending a state or grammar school or single-sex can also affect uptake across genders. Researchers Gill and Bell (2013) found that boys attending mixed schools were more likely to study Physics compared their peers in all boys schools, but that girls who studied in grammar, independent or all girls schools were more likely to take up Physics. The multilevel modelling analysis indicated that attainment alone could not explain the difference in uptake, as more females than males obtained A\*–C grades in Sciences and mathematics at the age of 16, with similar attainment between genders of grades B and above. It is, therefore, possible that part of the difference in career aspirations could be a reflection of higher education choices, which in turn are limited by prior attainment. For example, girls are more likely to have the entry requirements to apply for health-related courses such as medicine, whereas the boys may not meet the requirements due to lower attainment and as a result opt for engineering instead. Only the highest achieving students can study medicine at a limited selection of universities in the UK; it is considered one of the more challenging courses to access in higher education. Engineering courses are offered at a much wider selection of universities and allow for a much broader range of entry requirements. This explanation could suggest that attainment may be the causal factor behind some of the differences in subject choices.

With more girls taking Biology and more boys taking Physics in the UK the concept of gendered uptake in the Sciences is and has been pertinent since, at least, the early 1990s. Uncovering why this may be the case would help to explain this dynamic and enable those with the ability to affect change to do so, effectively. A review of research titled ‘Lost talent’ (Oakes, 1990) explored the relationship between educational policies and practices and the low participation of vulnerable groups such as women, minorities and the disabled in Science-related careers. The review states that although we do not completely understand the low participation rates of these groups, some evidence suggests that there are features of schools that constrain participation. These features of schools relate to opportunities to learn Science, achievement of these groups and students’ decisions to pursue Science careers. More importantly, Oakes points out ‘there is little theoretical research on how these factors work together or the relative contribution of each factor to participation (1990:26).’ More than twenty-five years later the gap between male and female uptake of physical Sciences is still significant. Boys are almost four

times more likely to take up Physics at A-level than girls, and girls 1.3 times more likely to take up Biology than boys with Chemistry the most gender-balanced of the three Sciences (Jin et al., 2011). While findings since the 1990s do not appear to have changed very much since then, society has changed, as has its values and so it is pertinent to have qualitative research that looks at how and why these findings are still relevant today and what the context may be behind some of the gendered uptake. Exploring the data contextually through this study could help to understand the current challenges faced by both genders.

Breakwell and Beardsell (1992) surveyed approximately 400 11-14-year-olds and showed that boys displayed a more positive attitude to Science, with greater levels of participation in scientific extracurricular activities, and self-reported as performing better at school Science than girls. This finding is significant when considered alongside a longitudinal study conducted by Oliver and Simpson (1988) who found a strong relationship between attitudes towards Science, motivation to achieve, self-concept of own ability and achievement in Science. This link suggests that girls may be at a disadvantage because their less positive perceptions of their attainment in Science may affect their motivation to achieve and overcome difficulties in Science. Lyons and Quinn (2010) provide support for this; they found that girls reported less self-efficacy than boys and that correlated with lower participation in Chemistry and Physics. This area was also researched within the OECD Programme for International Student Assessment (PISA) in 2007 (OECD, 2007), and self-efficacy produced similar gendered responses and was also closely linked to attainment. There are complex connections between gender, attitudes, self-efficacy and aspirations. While this suggests that there is a correlation, it does not demonstrate that there is causation. It would be interesting to explore how students build their perceptions of their ability and ideas surrounding their self-efficacy so that their views can be challenged if they are limiting their aspirations or encouraged if they are not. It was also pertinent to find out what external factors affected students' attitudes and aspirations, and whether there were any experiences they had that helped to encourage them to aspire for Science-based careers or enjoy Science teaching more.

Studies such as the more recent large-scale survey of 5034 students aged 14 to 15 (Mujtaba & Reiss, 2013) looked at identifying characteristics of those who intend to study Physics. They found that girls who wanted to study Physics post 16 were often

extrinsically motivated, that is motivated by how useful mathematics is seen to be for things like access to higher education or desired employment. The researchers also found that these girls had positive perceptions of their experience in Physics lessons and their teachers, as well as competitive and less extroverted tendencies. However, they were also less likely than boys to be encouraged to study Physics post-16 by teachers, family and friends. Verbal persuasions through both encouragement and discouragement relating to an individual's performance or ability to perform can affect a student's efficacy judgements (Bandura, 1977). Another study (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001) found that girls' confidence in their ability to succeed, their self-efficacy, in traditionally male-dominated subjects, such as Physics and technology, was much lower than boys' even though they scored similar results on standardised verbal and quantitative tests. When combined with reports from Quinn and Lyons (2011), one of the most popular reasons female students gave for not choosing Science was that they could not picture themselves as scientists, it suggests that there are deeper issues to do with gender stereotypes and identity that would affect their decisions. These studies show that under the umbrella theme of gender there are issues including self-efficacy, encouragement and future visions that are integral to uptake. In this study, data was gathered and analysed to explore differences in attitudes towards Science or aspiration. It is through exploring narratives of both genders that these themes could be unpicked with students to see how they have affected them as individuals, and the perception of these issues by those who are currently studying Science.

### **School-related factors**

With the government driving forward an agenda, where more students are to be encouraged into studying Science based subjects, there is an increased emphasis on schools to do what they can to increase student uptake. There is research that suggests that there are factors both in the classroom and structurally within the school that can proactively increase uptake. While in the past twenty years' work has been done to identify these features, the next stage is to understand the extent of the impact they have had, as well as how they affect uptake of the Sciences. Equipped with this information professionals can then make genuine structural and behavioural changes that could encourage a higher level of uptake for future generations.

Some researchers, such as Smyth and Hannan (2006) found that for similar groups of students the uptake of Science subjects differed between schools and linked this back to learning experiences. This finding was supported by Schoon, Ross & Martin (2007) who suggested that schools play a role in encouraging uptake of Science post 16 by engaging students in relevant learning experiences. Reviews by Osborne et al. (2003 & 2009) identified a key factor in uptake as the quality of the Science teacher during the compulsory phase. There have been more recent studies that have added to our understanding of the effect of teachers on student attitudes, interests and career aspirations through their feedback, expectations and encouragement (Hattie, 2003; Logan & Skamp, 2013; Rowe, 2003). Osborne et al. (2003 & 2009) and Hattie (2003) have also demonstrated that both a teacher's subject knowledge as well as the quality of their teaching is important. Studies by Hampden, Thompson and Bennett (2013), Gorard and See (2009) and Lyons (2006a) found that students enjoy lessons where teachers allow them to experience a variety of teaching and learning strategies. They also stated that passive activities such as remaining seated for prolonged periods of time, copying, note-taking, reading books and listening to the teacher could undermine useful practical work and that enjoyment. This finding is reiterated by Tai et al. (2006) who report that interactions between teachers and students are important in encouraging student interest in Science. Recent evidence by Archer et al. (2014) contradicts this and suggest that this variable has little to no effect on a student's aspirations and found that although the year eight students surveyed stated that they enjoyed doing Science in school, they did not aspire to be scientists. Interviewing students, in this study, about their school Science experience will provide greater insight into how much of an effect these aspects of teaching had on Science uptake or whether their role was limited to developing the Science learning experience during a student's schooling.

There were two further studies which used case study approaches to explore the successful strategies schools used to encourage students to take up Physics (Smithers & Robinson, 2007) and all Sciences post-16 (DCFS, 2009). They considered inspection reports, examination results and interviews with students and teachers. Smithers and Robinson (2007) identified key features of these schools to be strong departmental leadership, well-qualified enthusiastic teachers and the teaching of Physics as a distinct area at GCSE. The DCSF report 'Progression to Post-16 Science' (DCFS, 2009) draws



attention to similar strategies for retaining high attaining students in Science subjects after the age of 16. Consistently with the studies above they highlighted features, namely, enthusiastic and specialist Science teachers. However, they also identified additional teacher characteristics such as an ethic for teamwork, being engaged in professional development and having high expectations of their students. In turn, their students exhibited a sense of enjoyment in learning Science. Another study that supported this was carried out by Lyons and Quinn (2010) who surveyed 3760 Australian students aged 15-16 and found that teachers had more of an effect than parents on their subject choices and career aspirations. This finding is in contrast to findings from another survey completed in England, of 6597 students (Vidal Rodeiro, 2007) that suggest that parents seemed to have a bigger effect on students' choices at AS/A-level. Although this was not the only difference between the two studies, it suggests that the effect on students may vary according to their cultural environment. As such it would be interesting to find out who, if anyone, students indicate motivated them while they were making their A-level subject choices and what, in particular, they did that was effective. This study looks beyond identifying who was useful in supporting subject choices and look more closely on the behaviours or actions that helped the process itself.

Other studies looked at more structural and organisational aspects of the school curriculum. A study by the Department of Education (2011) found that there was a higher number of A-level entries in Local Authorities where triple Science GCSE was more prevalent. The strongest relationship was found to be Physics ( $r = 0.26$ ), followed by Chemistry ( $r = 0.19$ ), then Biology ( $r = 0.15$ ). Similarly, another study found that where a school offers separate Sciences at the GCSE level, the uptake of post-16 Chemistry and Physics is more likely to be high, even when taking into account attainment at GCSE (Gill, Vidal Rodeiro & Bell 2009). Data from 2008, shows that of the students who attained highly at key stage 3 (level 6+), 71% of those students studied a double award, while 20% studied triple Science. In terms of progression onto A-level Sciences, 45% of those who studied triple Science went on to study at least one Science A-level compared to 19% of those who studied the double award. When further filtered by attainment at GCSE of those who attained the highest grades (A/A\*), 75% of those that studied triple Science progressed to at least one A-level in the Sciences, compared to 59% of dual award students (Powell, 2010). This finding suggests that students were more likely to progress to A-level Sciences if they had studied a triple Science course. Perhaps the students

choosing between triple and double Science for GCSE have had to consider the impact this will have on future study and so were encouraged them to look into careers earlier on. However, a recent article by Archer, Moote, Francis, DeWitt and Yeomans (2016) contradicts this by suggesting that a student's choice for GCSE Science courses is not autonomous and that in many cases the decision is made for them by the school itself. This constraint may be another structural feature of the school that further limits uptake of Science for some students. Within this study, both students who studied double award and those who completed the triple award were interviewed to explore whether this has had any effect on a student's uptake from their perspective.

Some researchers have analysed national data sets in England looking at the uptake of the physical Science A-levels, namely Physics and Chemistry. They found that uptake was lower in comprehensive schools and higher in private and selective schools (Bennett et al., 2011; Smithers & Robinson, 2007; Vidal Rodeiro, 2007). The explanation for the gap in uptake could not be ascertained purely through quantitative research. Reasons could have been due to a wide variety of school-based factors, as well as broader effects on students including socioeconomic status. It is the more recent qualitative studies that have been able to identify some structural reasons for why some schools have been more effective than others at improving uptake into the Sciences. Foskett, Dyke and Maringe (2008) held focus group interviews with students from year 10-12 from 20 different schools, as well as with head teachers, heads of year and heads of careers in each school. They identified four dimensions of schools that affect participation post 16. These are whether or not the school had a sixth form, the characteristics of the school leadership, ethos and values of each institution, the socioeconomic status of students from the schools' catchment area and the organisation and delivery of careers education and guidance within the schools. Although identifies factors to look for this does not focus on uptake to the sciences and this limits the usefulness of the findings to this study. Within this study, rather than include a range of perspectives from stakeholders around the students, the focus was on the students. If the careers support was valuable or the ethos of the school was significant, students articulating that in their voice could be used to unpick whether particular aspects of it have been beneficial and more importantly how.

A qualitative study was carried out by Bennett et al. (2011) where the researchers identified ten aspects of school context that can potentially affect students' decisions.

These were school ethos, management turbulence, curriculum diversity at age 15-16, specialist Physics teaching, grade requirements for further study, career advice, work experience, extra curriculum provision, student ambitions and student empowerment. They stated that schools with a high uptake offered ‘a diverse Science curriculum in the final two years of compulsory study, set higher examination entry requirements for further study and, crucially, provide a range of opportunities for students to interact with the world of work and to gain knowledge and experience of Science-related careers (Bennett et al., 2011).’ They also compared schools with higher entry requirements, to those who required grade C’s and found that those with higher entry requirements had higher rates of uptake in both Chemistry and Physics. Perhaps this encouraged or motivated students to work harder to achieve the admission requirements. However, higher entry requirements may attract more able students from neighbouring schools; as such the importance of this link may be exaggerated. The researchers suggested that schools offering triple Science as an option choice, amongst a wider range of courses, were more likely to increase uptake of Physics and Chemistry due to the effect this had on the homogeneity of teaching groups. Within the past decade, however, there has been a real drive in increasing the proportion of schools offering triple Science as an option. It would have been beneficial to include this, as well as the relative effect size so that the context could inform the understanding of the data. The researchers also implied that teachers played a proactive role in recruitment for their specialist subjects and that this was in contrast to the role of career advisors who were more likely to encourage students to keep their options open. This study takes this further by focusing on just inner London students and seeing whether these factors have played a significant role from a range of student perspectives.

The majority of the research looking at school-related factors has originated from surveys and looking at data to identify trends. It was beneficial to look at how the range of factors was identified and perceived by students, through their own experiences. Within this study, the student voice through interviews was used to explore the perceived effect these factors had on a student’s decision-making and aspiration. In this way, rather than just the identification of a range of factors, insight was gained into how these factors can affect individual students on a personal level.

## Family & Society

As well as features relating to the student, Science (the subject) and the school, there are factors related to a student's background. These factors included a student's family background and ethnicity. Researchers such as Maltese and Tai (2010) & Sjaastad (2012) have shown that students are influenced by their relationships and daily social interactions with people around them with important people around them including family, teachers and peers. Archer (2003) suggests that the cultural capital a student gains through the knowledge, language and culture they experience can help to guide actions and decisions. The researchers suggest that as part of their social capital families with a network of social contacts can help students to access the best schools, universities and employment and so have an impact on their educational attainment and life chances. This is in addition to family factors including parental income, level of education and attitudes towards education that are socialised into their children and can help to motivate them in terms of thinking skills and wider reading.

The degree to which family impacts Science subject choice is unknown. Gorard (2010) has shown that if a child has a parent from a professional background they are more likely to aspire to have an academic education and enter into a professional occupation. This does not suggest which occupation or whether parents are involved in the subject decisions that would enable that to happen (Lindahl, 2007). While Foskett and Hemsley-Brown (2001) found that the parents influence on their children's decisions decreased with time, Cleaves (2005) found that this wasn't the case for all students and suggests that parents discourage their children from taking Science based on their own perceptions of the subject. She finds that more able students have more of a family influence in their decisions regarding subject choices. One key difference is that Cleaves (2005) study did not focus solely on Science students, whereas Lindahl (2007) did. Lindahl states that of the 80 Swedish Science students she interviewed only one reported they chose Science because of parental wishes. Both these studies would suggest that parental wishes were more likely to discourage students away from the Sciences rather than encourage them towards them.

Papanastasiou, & Papanastasiou, (2004) state that parental attitudes to Science education may influence student's attitudes to Science Education. Early research by Basit (1997) claimed that different ethnic groups have different ideas about what constitutes educational success, and so this may have some effect on a student's decision-making. According to Francis and Archer (2005), those of Chinese heritage base their educational aspirations for their children on safer routes towards success, rather than other factors such as the status of professional jobs or the perpetuation of social class. Therefore, if studying Science was perceived to be at higher risk compared to other pathways, then parents would discourage their children to pursue this route. Francis and Archer (2005) explain this exceptional ethnic group as one that invests heavily in education, socially and economically, and so prefer to opt for safer well-known educational routes for their children, perhaps to give them a better quality of life. Other researchers such as Gill et al. (2009) and Gorard and See (2009) found that there was a stratification of participation and attainment by students' socio-economic status and ethnicity. They suggested that the Caribbean and white students were less likely to take up Chemistry than Pakistani and Indian students who were more likely to choose it. They also found that Chinese students were more likely to take up Physics. Vidal Rodeiro (2007) showed that in comparison to the white group, Black African, Chinese, Indian, Pakistani students and students from a mixed background were more likely to take two or more Mathematics/Science subjects. The recent large-scale study, ASPIRES, (DeWitt et al., 2013) has addressed this by following 9000 year six students' aspirations in Science. One particular finding was that students who were of Asian heritage expressed higher aspirations in Science than other ethnicities and that this was mostly due to parental attitudes to Science. The researchers suggested that an environment where students' aspirations in Science flourished depended on students' attitudes to school Science, their self-concept in Science, parental attitudes to Science and possibly positive peer attitudes to Science and positive perceptions of scientists.

While the identification of factors that enabled and empowered aspirations in Sciences is useful, it is limited because it does not show how they interlink with each other or how and why they do have such an effect on individual students. For example, when asked to identify the value of who had influenced their decisions few students picked subjects their friends were studying, although they did discuss their choices with their friends (Blenkinsop, McCrone, Wade & Morris, 2006). This study had relied on students

identifying who was of value in their decision making but the underlying assumption was that they were aware of, and recognised, who had influenced them and that may not always be the case. Others have approached this from another angle and found that peers can affect how students experience Science, and as such attitudes to Science which is an established factor in their decisions (Reiss, 2000; DeWitt et al., 2011). Researchers have also found evidence that peer attitudes and interests towards the Sciences is a predictor of student enjoyment of Science (Aschbacher, Le & Roth, 2010; George, 2010) and that this can in turn enhance a student's vision of themselves as scientists (Stake & Nikens, 2005). While there is no direct link between peers and choice of Science for further study there is a strong suggestion that it contributes indirectly and so would benefit from further exploration. For many of the factors identified within the literature it is important to move beyond whether they have an influence and look at how they have an influence.

Analysing student narratives for information surrounding how these factors have affected students enables a deeper understanding of how we can positively reinforce these factors within society and the school environment. One particular researcher, Lyons, developed a model (Lyons, 2006a) looking at congruence between values held within multiple worlds students experience. He identified these 'worlds' as school Science, self, family, peers and mass media. He found that when there was congruence between the school Science world, the self and family world, there was a higher likelihood of students opting for Science subjects. There was a link identified between the uptake of Science and a families' strategic emphasis on the Sciences as a pathway to formal education. He found that families of students who were less likely to opt for Sciences were more likely to suggest students choose subjects they were good at or enjoyed. This finding would suggest that mass media and peers were much less influential in a student's subject choices, and perhaps more emphasis needs to be placed on family support for such careers. A Norwegian based study (Sjaastad, 2012) that supports the above, and suggests that interpersonal relationships formed by students with their parents and teachers could be inspirational in students' subject choices. The study found that parents engaged in STEM themselves are models, made choosing STEM familiar and that they helped youngsters define themselves through conversation and support. Teachers similarly displayed how STEM might bring fulfilment in someone's life, through giving students a positive experience and helping them to discover their abilities. In light of this, this study explored the relationships students mention, and the type of people they say they interact

with regarding their career aspirations of subject choices. It would be useful to know who has supported them through their decisions and how, as well as the relative importance of different interpersonal relationships in their choices.

### Theoretical frameworks for understanding post-compulsory choices

The initial section of the literature review looked at isolated factors and how they can affect a student's uptake of the Sciences at the post-compulsory phase. During the process of decision-making, this range of factors is combined to make a decision. A theoretical framework for the choice process will allow a deeper understanding of how the combination of these factors come together for an individual. The researcher's understanding of decision-making underpinned the framework, which is the structure that supports the research study. Exploring the role of structural features and personal autonomy in students' educational choices is a challenging area to study with diverse models to consider. For example; Are students' social actors actively engaged in their decision-making? Or are they governed by social constructs and forces that pre-determine their future? That is the question that underpins most models surrounding choice. Within this section is a summary of some of these models, including a discussion of some of the theoretical approaches that relate to the decision-making process. They have been used to help develop a model to apply for analysis of the data within this study.

Both psychological and sociological perspectives can be used to explore the dynamics of human behaviour. Psychological perspectives focus on the study of the human mind rather than society. Whereas a sociological perspective is a perspective on human behaviour and its connection to society as a whole. It allows an explanation for the connection between the behaviour of individual students and the structure of society in which they live. Previous studies have identified social factors including gender, ethnicity, religion and socioeconomic status as influencing STEM choices. Data highlighted as part of the 'London effect' suggests that a sociological approach focussing on students within that population and focussing on learning about how those identified factors play a role in decision making for students could develop our understanding.

Sociologically, Bourdieu (1977) argued that the role of decision-making within education is one of cultural reproduction. His theory suggests that social class membership is passed on through generations and that the educational system is the mechanism of transmission that also helps to legitimise the disparities between social classes. However, this theory would suggest that individuals have little agency in comparison their society and circumstances. He explains that one of the two fundamental features of the way it achieves this is through imposing class culture on a person's behaviour and the way they internalise their chances of success. This culture exhibited through their lifestyle, values, characteristics and expectations: their habitus. In turn, this habitus creates a predisposition of what people consider as being for them and not for them respectively. The second feature is a person's cultural capital; this refers to the symbolic, social and material possessions a person has because of their culture. The combination of both features can facilitate success, wealth and power for those of dominant classes while reinforcing failure, poverty and weakness in the case of the subordinate classes. While Bourdieu does not completely rule out individual autonomy or freedom of choice, in his view social constructs play a much more dominant role through the dispositions they create in preserving cultural reproduction. The structural constraints referred to as key factors include social class, gender, religion, ethnicity and customs.

The similarity between the factors raised by Bourdieu (mentioned above) and those identified within the literature review below suggest that there is a strong case that there is a limited role for personal agency when it comes to decision-making. This outlook, however, does not show appreciation for how these factors can link to each other and the degree by which they affect individuals. It also does not take into account the evolution of technology and mass sharing of ideas, advice and information through avenues such as the internet, and the critical role they may have played in breaking down conventional social and class barriers. For example, unlike twenty years ago, access to information about a range of careers is now available online, along with information about how to gain entry into numerous fields. Indeed, explaining contemporary social inequality may help us to change the proportion of underrepresented students going on to study Science post 16, as it may help us understand how to break these cycles. There is some controversy amongst social scientists about the extent to which social actors (the students) can actively engage in and control the choices that shape their lives, in the context of the more dominant social structures that can regulate human behaviour (Patton, 2005). Researchers



such as Patton suggest that these structural constraints can affect the opportunities that individuals have, therefore limiting or guiding their choices.

Archer, Dawson, DeWitt, Seakins and Wong (2015) have taken this further and suggested that students have with them a 'Science capital'. This capital contains the student's Science-related experiences, interests, knowledge and resources. They concluded that when a student's cultural capital is high, their Science capital is often high too. Students with a high Science capital were more likely to aspire to study Science at university than students with little Science capital. However, capital is not just an amount but also a trajectory and so while it is useful to explore and identify factors that contribute to a student's Science capital, understanding how these can be utilised on a trajectory towards the uptake of Science at post 16 would allow for a comprehensive understanding. The inherent factors within the concept are consistent with those identified in the earlier part of the literature review from established literature in the field. Although this concept is theoretically useful there has been no evidence to date that increasing a student's Science capital increases the likelihood of them choosing STEM subjects.

One longstanding comprehensive framework is the expectancy-value model (EVT) of achievement-related choices (Eccles & Wigfield, 2002). Researchers working on projects such as Interests & Recruitment in Science (IRIS) and the Relevance of Science Education (ROSE) have drawn on aspects of this framework to address young people's educational choice processes and their relationship to STEM. While Eccles EVT model looks at how the individual functions within society, this thesis takes a more sociological approach by looking at how the society functions for a particular group of individuals. The expectancy-value theory developed by Eccles et al. looks the individuals making subject choices without outside agency. It takes into account the role of value and expectancy of doing well in a task when making a choice. It predicts that students are most likely to choose courses in which they have high expectations of success. It suggests that students are more likely to take up subjects they see as useful and where they are likely to be successful. As such they suggest that people choose to pursue goals that are realistic, attainable and desirable. Enman and Lupart (2002) found that Eccles model was generally ineffective as a predictor of student choice to undertake further study of Science, although one factor that did prove effective was students 'self-concept of ability'. In addition to this, the research particularly on choices in Science education have

shown that alongside personal factors such as age and gender the choices are also influenced by economic, cultural or institutional constraints. Lent, Brown & Hackett (1994) argue that personal factors including self-efficacy and personal goals enable individuals to exercise agency in their own career development. They are also informed by race, gender, learning experiences, social support and social barriers and that a combination of all of these can come together to influence career choices and interests. As such a sociological approach, would be suitable for this study.

One of the key mechanisms raised within the literature, focusing on initiating change, is a recognition that there is a need for social phenomena to be looked at through the concept of agency. We can increase the dominance of a social actor's agency through increasing their capacity to choose freely and empowering their ability for action (White, 2007). These approaches do not necessarily ignore the role of social constructs raised by Bourdieu (1977) however, they do provide an empowering sense of change moving forward and in doing so allows researchers to break or challenge the social and structural constraints that we acknowledge could limit an individual's choice. An example of this in action would be an exploration of where students get their 'sense' of Science not being for them. Gaining an understanding of how this value develops is integral to understanding some of the choices made (Jenkins & Nelson, 2005). It would also help to challenge these values or to prevent their formation for other generations. This interplay between structural constraints and an individual's autonomy has led to a variety of models being developed to explore decision-making. While none of the models will ever fully capture the reality they are designed to explore; they all offer some insight and usefulness when examining the process of choice. In the following section the strengths and weaknesses of some of these models are discussed initially and then a suitable model for use within this study is selected.

### **Selection of model**

When selecting a model to inform the study, it was important that the model took into account the range of factors identified in the literature review, as well as offered an insight into how these were interlinked and informed the decision made. There are five models discussed below. The first two models provide some insight into the sequencing of the

choice process as well as where the factors fall into the sequence, and the next two models look at selection strategies used by the students. There is a comparison of the models discussed, after which, an adapted model, taking into account aspects of all four is explained.

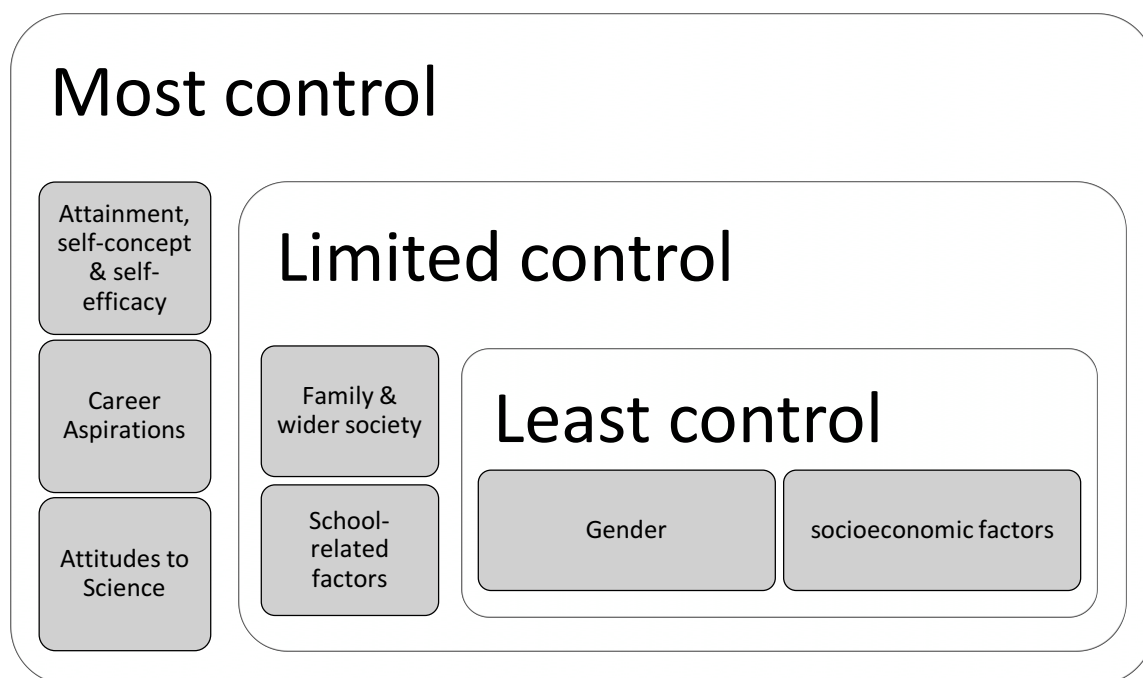
One model that focuses on the sequences in the context of college choice is that suggested by Hossler and Gallagher (1987). This framework is based on three main stages in the decision-making process, namely predisposition, search and choice; all three of which focus on the student rather than on external factors. This model includes the dimension of time; including the length of the decision-making process and the main sequence of the stages that may affect the final choice. In the context of A-level options, the predisposition would be the decision to study A-levels, the search would then be collecting information about the courses and the choice would be the final selection. On the surface, this appears to fit nicely into the study and may help to interpret the way students make their decisions, but its weakness lies in its simplicity, and as such may not add so much regarding analysis to this study. The separation of the choice process into stages is something is used during analysis.

Hemsley-Brown (1999) used a similar model. They carried out a two-year longitudinal study focusing on 16-year-old students' college decision-making choices and examined both their perceptions and priorities. She distinguished between two main stages; the preliminary stage and the refined search stage. The classification of choice here into two stages rather than the three mentioned earlier shows an awareness that predisposition and search are interlinked and also not necessarily sequential.

Hemsley-Brown (1999) showed an improvement on this where the preliminary stage was where students focused on preconceived influences from parents, teachers and peer group. This stage was organised into preconceptions and psychological defence mechanisms. The preconceptions included social and cultural frames of reference, self-image and group identity. The psychological defence mechanisms included distortion and exaggeration, post hoc justification, self-deception and self-appeasement. The second search stage involved the collection of information from the colleges themselves through open days and prospectuses as well as career sessions. During this stage students, would consider the information and make a choice, without necessarily being free from the

preconceptions within stage one. She also suggested more academically inclined students entered stage one knowing a lot more information compared to less academically inclined students. According to Hemsley-Brown students use the first stage to filter the second, and some use the information from the second stage to justify their choices, without necessarily being rational about the objectivity of the information. An example of this is if a student at stage one gained strong preconceptions about vocational pathways being a waste of time and ineffective in university entry, then when they embark on stage two, they would not collect information about vocational routes, missing pathways such as apprenticeships. Conversely, if a student had strong associations built during stage one that included finding STEM subjects difficult and boring, they could enter stage two without gathering any information about the further study of these courses. This model appears to build on the strengths of the Hossler and Gallagher (1987) model while allowing for a more sensitive and in-depth appreciation of the choice process. While this model is useful in understanding the phases, it does not explain fully the detail of how these factors lead to the decision being made by the student.

Building on the structure of the above two models, the model used in this study separates the factors identified within the first section of the literature review as influencing decision-making into three main groups, based on the degree of control a student has over them. This builds on theories from psychology that look at factors in terms of locus of control. A locus of control here indicates the extent to which individuals believe that they can control events that affect them. A factor with a high internal locus results primarily from our own behaviour, and a factor with a high external locus is determined by chance or by the actions of other people. The application of this here is in terms of layering the factors based on this rather than analysing an individual's belief about their potential degree of control. The layers are shown in figure 1 below. Within the limited control section, there are two factors that students have the least control over and these are their 'gender' and 'socioeconomic factors'. Students have limited control over their 'school-related factors' and their 'family & wider society'. The final group contains the factors where the students have the most control, and these are 'attainment, self-concept & self-efficacy', 'career aspirations' and 'attitudes to Science'. These are also the variables suggested by Tripney, Newman, Bangpan, Niza, Mackintosh and Sinclair (2010) as appearing to be of most influence. The links between these factors were explored further in the analysis of the data.



*Figure 1 Initial groupings of factors emerging from literature based on degree of control of student*

In another study, a different model was used by Bennett et al. (2011) who used large-scale data from the National Pupil Database (NPD) to identify two groups of schools, one group who had a high uptake of the Sciences and another in a similar context that had a low uptake of the Sciences. They compared the two groups and looked to identify factors that made a difference to the uptake, including the strategies students used to decide on their A-level choices. To do this, they drew on earlier research regarding students' decision-making processes at A-level. They concluded that while there are a variety of strategies students used to make their choices, there are differences between strategies students used in high uptake schools compared to the lower uptake schools. Lower uptake schools are found to have students that used a wider variety of strategies to reach their decisions. By contrast, students in high uptake schools appeared 'to make a proactive choice in relation to career aspirations, rather than a reactive choice on the basis of past experiences' (Bennett et al., 2011: 3). The researchers identified nine school-related strategies used by students for their subject choices. They grouped these into five groups, as outlined in table 2 below. The five strategies identified as; based on a student's aspirations, their sense of identity, their tactical approach, their experiences or on external factors.

Type	Description of selection strategy	Grouping
1A	I know the career I want to take and selected my subjects accordingly	Aspiration
1B	I know the university course I want so my subjects are prerequisites	
2	I know the subjects I enjoy and selected a university course accordingly. This guided me in the selection of my subjects	
3A	I know what type of person I am and thus the area of knowledge I will enjoy. This guided me in the selection of my subjects	Identity
3B	I have confidence in my abilities to study particular subjects	Tactical
4A	I have selected my subjects such that I reduce risk	
4B	I have selected my subjects in order to keep my options open	
4C	I have selected subjects that go well together	Experience
5	I have selected my subjects on the basis of the subjects I have enjoyed	
6	I have selected my subjects on the basis of who taught me	
7	I have selected my subjects on the basis of the subjects I am good at	Entirely outside
8	I have selected my subjects according to what was available on the timetable	
9	I was told to take these subjects by my teachers or my parents	

*Table 2 Pupil's strategies for selecting their subjects (Bennett et al., 2011: 12)*

This model offers some useful insight into the process students undertake but given previous experience when using this during the Institute Focussed Study (IFS) stage, a significant proportion of students used overlapping strategies, and the groupings were not sufficiently distinct. It was also difficult to differentiate between selection strategies based on identity or experience because they were interlinked in several cases. On further reflection, although the groupings above allowed some insight into the main motivations behind the subject choices they were not necessarily distinct enough strategies for decision-making over time. This grouping was a particular challenge because several of these factors affected students to some extent and so knowing which one had been the overall driving force was challenging.

The last model to be discussed was developed by Cleaves (2005), who conducted a three-year longitudinal study of high-achieving students in England, where she interviewed each student four times to get an idea of how a student decided over time. Cleaves focussed on human and material resources were used to shape different choices over time. She interviewed students twice in year 9, then in year 10 and then in year 11. She did not interview after they made their final decisions. In contrast to Cleaves use of the framework, students in this study were only interviewed once, and their retrospective accounts of their decision-making were used to match up their trajectories. Students spoke

about school subjects, interests, preferences and thoughts about their educational future. As in Cleaves's study, this study analyses the data by first looking to identify the range of factors the students mention in light of those raised in the literature review. Similar to the researchers mentioned above, Cleaves found that students approached the issue of choice dynamically and had considered a range of factors. She suggested that there was 'an interplay of self-perception with respect to Science, occupational images of working scientists, relationship with significant adults and perceptions of school Science.' (ibid: 1). Students were aged 13 to 16, and interview analysis focused on how their post-compulsory choices formed over the last three years of their secondary schooling.

Cleaves (2005) had used grounded theory approach to inform and adapt her questions for the interview and for generating theory. She analysed them transversally and longitudinally over time and used the analysis to identify emerging themes and discover patterns. Discourse analysis, assisted by HYPERresearch qualitative analysis was used to code and cluster the data. The hypotheses were then tested to reveal five different choice trajectories, which formed the theoretical basis. These trajectories aimed to take into account both the students' reasoning for why they had made particular choices as well as when they had made these decisions.

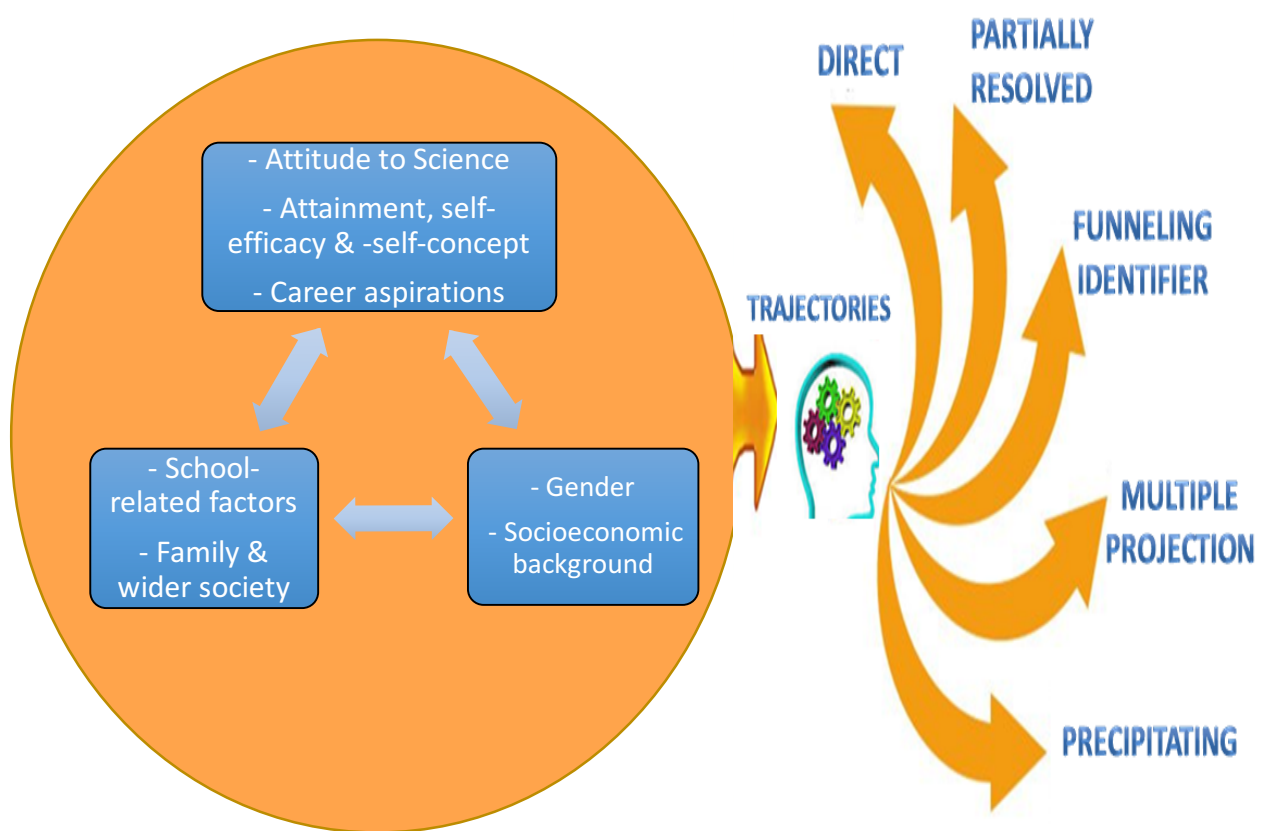
She classified the process into five different 'trajectories'. These are named direct, partially resolved, funnelling identifier, multiple-projections and precipitating trajectories. A direct trajectory is one where a student has a high visibility occupation or career in mind; these students had the most stable subject commitment. A partially resolved trajectory is one where students had not necessarily chosen a career but are aware of the usefulness of their subject choices for future careers. Another trajectory is that of the funnelling identifier. A student who followed this pathway uses a method where they narrowed their choices over time. A multiple-projection trajectory; where students continually change their minds about their subject choices. Finally, some students use a precipitating trajectory based on wider interests or skills, without a careers focus. A best fit approach was used to identify trajectories and where the trajectories had changed over time Cleaves decided to focus on the trajectory nearest the point of choice as determining. As such, it is reasonable for me to then conduct a retrospective study and to use an interview in year 12 to look for a closest match in trajectory in a similar manner.

Comparing Cleaves's model with that of Bennett et al. (2011), it is clear that there is a parallel between the aspirational group and the direct trajectory – where students who used this did so for reasons reliant on a particular career or university course. There was also a parallel between the tactical group and the partially resolved trajectories – where students had an understanding of the usefulness of their subject choices and had used this primarily to keep their options open, flexible or to reduce risk. The key difference came with the distinction between the remaining three categories. While Bennett et al. (2011) focus the groups around the student's identity, experience and external factors; Cleaves instead concentrates on distinct strategies, in light of how the decision may have evolved. For example, the precipitating trajectory appears to be a combination of Bennett et al's identity and experience groups merged with an appreciation of time. A funnelling identifier focus on a student who chooses to filter options out over time and could do those based on a range of reasons – Bennett et al. (2011) do not have a parallel to this strategy. Equally missing is the multiple-projection trajectory where students change their minds about their subject choices. For this study Cleaves (2005) trajectories are used as they are more comprehensive in their approach to pathways in this context. Given that there is substantial literature about the range of factors Cleaves trajectory model serves as an excellent platform to help understand how they come together to reach a decision.

Consideration of the above models informed the framework adopted in this project. This study used the five trajectories identified by Cleaves's (2005) model, alongside the factors identified below in the chapter. The combination of both of these allowed for the most insight into how students reached their decisions. Analysis of the decision-making occurred in two phases. The first phase looked at identifying the range of individual factors and how they may have affected students. Knowledge of these factors helped to inform the themes that emerged from the interview but was adapted when more suitable codes emerged from the data. The next stage involved using the best fit model to see which of the trajectories best described the method used by the students for making their final subject choices. Figure 2 represents how this adapted model will take into account the range of factors that came from the latter section of the literature review. These are shown to form the basis for all students. The interviews with students will allow some understanding of which factors have more of an effect on individual students, as well as how they combine uniquely for each student. The model is unique in that it divides educational choices for Science into two phases. The first phase takes into account distinct



factors that affect the decision-making process; including the individual, the background and the school (as identified in the literature review below). The second allows for possible routes that allow us to envision choice and decision-making as a journey with a range of potential pathways and outcomes rather than just a combination of factors or stages. This framework helped me to come up with elements of mixed method which fed into the analysis and allowed me to see alignment between factors that were emerging from the data.



*Figure 2 Visual representation of the initial model for the conceptual framework*

This model forms the basis of the initial conceptual framework that was used to analyse the narratives of students during this study. While this study may not have the longitudinal aspect of time that Cleaves (2005) did, it is still useful to know which of these strategies students, who choose Science A-levels, may be predisposed to because that may help us

to channel resources, opportunities and advice to them. In addition to this, the factors that feed into the first stage of the model are known to affect a student's choices, however analysing them for how students use them in this context would add to our understanding within the field. More effective planning for the decision-making process can be put into place using the results from this study. A richer appreciation of the range of avenues by which younger people make choices, helps us plan a range of interventions and support so that more students choose to study Science A-levels and consider Science careers.

## Reflection

The above literature review summarises a broad range of factors that existing research suggest as having an effect on subject choices at A-level. They have also helped to inform the structure of the instruments for the data gathering phase, as well as provide a framework to help interpret and analyse the data. It is clear that this area has attracted much research internationally, however, while some studies have focused on England, few have been based on an inner London context, or based on a sample of A-level Science students after they have made their option choices. The factors identified through existing research have included students' experience of Science in school, structural aspects of schools, students' characteristics, including their age, gender and socioeconomic background. However, there has been limited literature on how the combination of these structural, social and individual factors work together to affect a student's choice to study Science from a student's perspective. This is the intended research focus which underpins the rationale for this study and aims to extend the findings of established research within the field.

## Methodology

As summarised in the literature review, there is substantial research on students' attitudes to school Science; there is also some research that focuses on identifying factors that could affect the decision to study Science after the age of sixteen. The literature on how the combination of these social and individual factors work together to have an impact on a student's choice to study Science is not as substantial. Tripney et al. (2010) suggest that there was a lack of high-quality research in areas of factors affecting subject choices; between 1988-2008, the researchers state that there were only twelve such studies. Bennett, Lubben and Hampden-Thompson (2013) suggest the need for more research on factors that affect inter-school variations of uptake of STEM subjects. They also suggest that other individualised links that could have an impact on the uptake at the post-compulsory stage need further research; this includes self-efficacy, performance, engagement, participation as well as age by which students have made career decisions. This research project is original in its focus on solely inner London students who have chosen to study Science post 16. It uses their narratives to explore the factors these students describe as having affected their A-level option decisions. It also looks at their decision trajectories and explores the overall strategy they used to reach their decision. The chapter aim is to outline and discuss the research methods employed in this investigation to address the research questions.

### Rationale for mixed methods research approach

The inherent values held by a researcher and the context within which they operate affects their perceptions of 'reality' and so similarly the tools and approaches they choose to explore it. An appreciation of this within this study allows for an exploration of the research questions rather than a search for a single reality or answer (Giarelli, Chambliss, Sherman & Webb, 1998).

In a dynamic society, with the broad range of schools available, it is impossible to isolate and control the many factors that could affect the results of this study. Positivist research projects and their findings may be non-transferable to teachers as they are often carried out in social contexts where variables need to be controlled and accounted for. In contrast,

a constructivist approach could reflect the reality of the situations as they occur (Secker, Wimbush, Watson & Milburn, 1995), with its appreciation of socially constructed realities (Mertens, 2014) and through doing so allow the research to explore the world of human experience (Cohen, Manion & Morrison, 2013).

This study relies upon the participants' views of the situation being studied while recognising the potential impact of a researcher's background and experiences on the study (Creswell, Plano Clark, Gutmann & Hanson, 2003). Häussler and Hoffman's (2000) interpretation of interest and choice as being rich and multifaceted, allows for a deeper understanding of the more complex, more subtle side of the student experiences and interests. As this includes the effects that are otherwise unobservable such as the thought processes, feelings, values and preferences that shaped student choices, qualitative approaches were needed (Harding & Gantley, 1998; Neuman, 2002; Punch, 1998). In addition to this, quantitative studies have proved useful in isolating factors that affect students' uptake of subjects and attitudes to them, used alone they run the risk of superficially exploring complex social relations and phenomena. Qualitative studies allow for the richness of the cases to be investigated and portrayed (Cohen et al., 2013). They also offer the potential for a more holistic understanding of a phenomenon, through the selection of cases to be explored. However, if used alone, these be interpreted subjectively and so may introduce bias. These reasons explain why neither quantitative or qualitative methods have been used exclusively in this study.

The mixed method approach used in this study takes a society as it is, and allows the exploration of the research questions without limiting the relatability of the research to those researched. Patton (2005) and Bryman (2008), both argued for a 'paradigm of choices' so that researchers have the option of choosing not to follow a paradigm rigidly. This freedom allows the opportunity to combine the strength of the qualitative and quantitative paradigms, without necessarily combining their weaknesses. According to Johnson and Onwuegbuzie (2004), mixed methods approaches can be applied to help methods to complement each other and allow the researcher to seek further elaboration, enhancement and development by allowing the results from one method to help inform the other. For example, White (2007) and Foskett et al. (2008), doubt the validity of students' self-reporting time frames, through questionnaires. However, Gorard (1997)

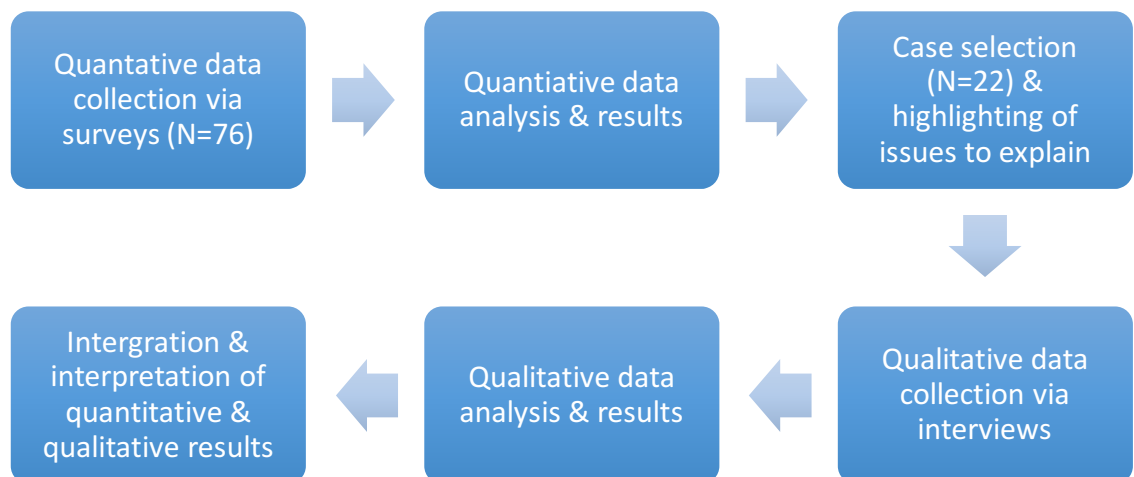
suggests that using qualitative narratives may enable students to detail their stories more accurately. In keeping with Wolcott's (2002) advice, rather than placing the two approaches in opposition, this study allows them both to contribute to each other, allowing for a fuller picture by combining the information derived. Rather than impose an approach on the study, the research questions lend themselves to different tools, and as such a range of methods. Quantitative methods are used to analyse the overall picture and the information generated is then used to select cases to explore further in a qualitative manner (Punch, 1998). The combination of these methods provides converging evidence for the research questions and allows for a thicker descriptive interpretation of the findings. The ultimate aim is to gather sufficient information to be able to understand and explain the phenomenon of subject choice at the A-level stage, and these methods should enable that while making the best use of both.

A mixed methods research approach is one where researchers collect, analyse and integrate both quantitative and qualitative data in a single study to address their research questions (Creswell, 2005). The approach is used because the use of qualitative or quantitative approaches alone were insufficient in understanding 'what' factors affect the decision making, 'how' the factors link together as well as 'why' students make the overall trajectory decisions that they do. In order for a study to be deemed a mixed methods study, it must have both types of data collected (quantitative and qualitative), and it must bring these both together (Creswell, 2005). The combination of both qualitative and quantitative models complement each other and can provide an in depth holistic appreciation of the research questions (Johnson & Turner, 2003; Tashakorri & Teddie, 1998). Denscombe (2014) shares that it is important for the researcher within a mixed methods approach to explain three aspects of their research design. The first is the sequence of the qualitative and quantitative components. The second is the relative importance attached to qualitative and quantitative components and the third is the purpose of linking the qualitative and quantitative components.

In this study, the rationale for using mixed methods is twofold. The first reason is predominantly pragmatic as it allows for the relationships found from the quantitative approach to be explored and enriched using information from the qualitative approach (Creswell & Plano Clark, 2011). While the information from the quantitative data

provides an overall picture of the research area, the refining of the choice model can be further developed using insight from individual narratives (qualitative data) to explain the general picture. The second is to allow for a purposive sample using the data from phase one to inform the selection of participants in phase two.

This mixed methods study will address the area of students' A level subject choices using an explanatory sequential design. Figure 3 shows the mixed methods explanatory sequential design used in this study. The design consists of two distinct phases where the first quantitative phase will be used to generate numerical data for description, for comparing groups, for relating variables to each other and exploring influences. Primarily this will determine which variables correlate with the choice of a particular Science A level and which correlate with a higher number of Science A levels. The second qualitative data analysis of the semi-structured interviews will focus on exploring this issue through coding, the development of themes and relating the themes to each other to generate meanings into the choice process. The quantitative data collection and analysis took place first, followed by quantitative results. The quantitative results that may have benefitted from probing were highlighted. Then the qualitative data collection and analysis took place followed by qualitative results. The results from both phases one and two were integrated in the discussion. There are two points of interface in this study where both the quantitative and qualitative may be mixed (Creswell & Plano, 2011; Denscombe 2014). The first is during the data collection phase, where the information from the first phase is used to select cases for further study during the second interview phase. The second is during the interpretation phase when combining results from both methods.



*Figure 3 Steps followed in data collection and analysis*

In this study the preliminary quantitative results help to give an overall picture and to help select participants that will better inform understanding of the research area through the follow up qualitative phase. As such, the priority is the qualitative data collection and interpretation of this, as this feeds into the theoretical model and allows a deeper understanding into the choice process.

In terms of methodological perspectives, there is a prior frame of reference gathered from both the literature review, as well as from the researcher's previous experience of a similar study during the Institute Focused Stage of the course. The interpretation is thus primarily deductive when analysing both the questionnaire and the interviews. The ontological assumption within this study is that the reality experienced and interpreted is subjective. The relationship between the researcher and the researched, contains frequent interaction with some of the participants both before, during and after the research, although not necessarily all of the individual students, and not when they are making their choices. Given this, assumptions are made explicit during all phases of the research including when seeking permission to research, during the data collection and when writing up this study, as per the guidance of Creswell et al. (2003).

### **Structure of the research**

The collection of data took place in two phases. The first of these was a quantitative survey to year 12 A-level Science students in an inner London borough. The questionnaire consisted of a structured questionnaire, with close-ended questions. My initial use of a questionnaire was to collect large data quickly and efficiently. The results served as a recruitment tool for the second stage of the study. The second stage utilised the results of the questionnaire to select a purposive sub-set of these students for one to one semi-structured interviews. A detailed explanation of the two phases is below.

The use of questionnaires were suitable in the first phase because it allowed for relatively easy, quick administration to a relatively large sample, and analysis of the data could highlight some of the differences between subgroups. The larger the sample, the more effective this instrument would be, although by its nature it would be limited in terms of

the depth of responses. A related advantage is that questionnaires permit us to make comparisons over time, by asking identical questions at different times, other researchers could use the same questionnaire and compare the results obtained. This is an advantage that cannot be related to many other methods of social research. I considered doing an online questionnaire to further save on time and inputting of data. However, I felt despite it being easier for me, it would not necessarily be easier for students given limited access to computer resources, and this may have had an impact on who responded and may have required teachers to arrange computer access. I felt that the paper approach, while more cumbersome for me, would give me a better response rate, as well as guarantee confidentiality in the conventional route as expressed in the ethical approval section. In addition to this, asking the class teachers to administer the survey in a school setting limited the chance of observer subjectivity affecting responses and increased the validity of the questionnaire, compared to administration by unknown researchers. The majority of the survey was structured using closed questions, and this increased the chances of students completing the questionnaire within a reasonable timeframe. Having limited responses may have affected the depth of the data collected through this instrument, however having follow-up interviews allowed for an opportunity to clarify or add depth to the concepts from the survey.

The second phase consisted of follow-up interviews with a smaller number of students. Interviews gathered richer, more descriptive empirical data, although the transcription was labour intensive. This stage used a more naturalistic approach to analyse the qualitative data using the conceptual framework selected for this study. This phase allowed data collection which focused on research questions; namely, on students' reasons for choosing A-levels in the Sciences, their perception of the choice process as well as looking at the factors and strategies they used when making their subject choice decisions.

I was keen to use an instrument which would enable me to gain insight into this process, and in doing so focus on how and why the various variables identified within the literature review interplay with each other in the process itself. Foskett et al. (2008) and Hemsley-Brown (1999) explained how decision-making formed and evolved. If time had allowed, I would have preferred to follow a longitudinal study with students over the course of



transition to see how this developed in this context. However, this was not possible given the constraints of my time.

Initially, focus group interview sessions were considered rather than interviews for phase two. A focus group interview is a discussion about a topic that is of interest to the researcher. According to Gomms (2008) these group interviews can increase the range of types of people that can be interviewed and allow a rich coverage of the research topic. Focus groups would have had the benefit of allowing the students' views to emerge through their interactions with each other, rather than with the researcher (Cohen et al., 2013). However, given that students had very individual choices, it was more important to give a voice to their independent choice narratives without running the risk of them agreeing with the most vocal within a group discussion (Gomms, 2008). It could be that some respondents may answer questions differently depending on who is listening and how it may be perceived by others. In group interview situations, there is no guarantee that participants will guarantee each other confidentiality and as the information shared is personal this may limit the information the participants choose to share (Cohen et al., 2013). Morgan (1988) states that *'The hallmark of focus groups is the explicit use of group interaction to produce data and insights that would be less accessible without the interaction found in a group'*. As one of the main aims of the project was to see how the factors identified linked together for individuals it was critical to keep the narratives separate. Instead, I decided to carry out in-depth qualitative interviews with the aim of uncovering the depth of their individual choices. Punch (2009) states that interviews enable the researcher to access people's perceptions, meanings and constructions of reality. Conducting these interviews as semi-structured allowed me to ask some important questions arising from the literature, as well as providing flexibility in terms of follow-up questions that could be used to further probe and clarify some of the student responses. They were also relatively easy to set up and carry out and would fit around my other commitments. The questions chosen were open-ended, direct, simply phrased and not leading in nature (Bryman, 2008) and had been previously trialled during the Institute Focused Study. Although the conducting of and transcription of the interview data was time-consuming, it offered the opportunity to record rich, valuable data, in real time (Robson, 2002). Data from the interviews were transcribed and then thematically analysed. This process is explained below and is based on refined themes from the literature review, as well as from the Institute Focused Study.

Data from the two sources were reviewed and analysed to see whether the data converged. This analysis served as some measure for between-method triangulation. Ho (2006) argues that although interviewing can be used effectively to gain insight into interviewees perceptions, it can also work well alongside other methods to gain further depth about a participant's inner values and beliefs. Neither of the methods used would have been sufficient solely on their own to draw conclusions, but the combination of them both together adds to the rigour and so the credibility of the study (Jakob, 2001).

## Sampling

The sample area chosen for the focus of this study was an Inner London, because its high levels of attainment and progress at key stage 4 have been shown, via quantitative analysis to lead to be better educational outcomes for students post 16 (Greaves et al., 2014). I chose to focus on the borough I worked in for reasons of pragmatism. Schools were invited to participate in the study if they served the local community by educating across all key stages to 11-18-year-old students, had attainment that was higher than the national average (in terms of proportion of students with 5 A\*-C, including English & maths) and had been rated as at least good by Ofsted. In terms of students who were sampled, I opted to explore attitudes of year 12 students because they are more mature and are more likely to have actively engaged in reflecting on their interests and personal priorities as they had just decided on their subject choices. In turn, this meant my data would be more dependable. I felt that year 12 students had just made a fresh decision so were more likely to remember and be able to discuss their decision-making strategies compared to the year 13 students who may have forgotten, given it was more than a year and a half ago for them. The sampling criteria are summarised in the table 3.

Sampling criteria for Schools	Sampling criteria for students
<ul style="list-style-type: none"> <li>- taught students aged 11-18</li> <li>- In the inner London borough where I worked</li> <li>- attainment that was higher than the national average (59% in 2012)</li> <li>- Were rated good or outstanding by Ofsted</li> </ul>	<ul style="list-style-type: none"> <li>- Attended a school that fit the selection criteria</li> <li>- School had agreed to take part in the study</li> <li>- Were in year 12</li> <li>- Were studying at least one Science A level</li> </ul>

*Table 3 Sampling criteria for schools & students*

Ofsted data and published results statistics were used to narrow down particular institutions to approach and found that there were six schools with sixth forms attached in the local authority I had chosen in North London. Recruitment letters were sent to each of these sixth form's early in the autumn term so that it was as close to the student's decision-making (Appendix 2). In some cases, I then followed this up with a further e-mail and contacted the head of Science within schools to discuss the project. Following this, I then sent follow-up information sheets with questionnaires for potential participants to Heads of Science to administer the surveys (Appendix 2). Three schools chose to participate. Based on the data from these surveys a sample of students who were studying at least one Science A-level would be selected and contacted via their institutions for follow-up interviews. This data from the interviews were transcribed and analysed. All three schools were surveyed in phase one of the study, and two were selected for interviewing students during phase two of the research.

The study design evolved and developed over the course of the project. Initially, I had hoped to collect data from six different schools within the borough and to include twenty-five Science students and twenty-five non-scientists from each school. This sample would have totalled 300 students and would have allowed for a larger sample for my questionnaire on which to base more valid conclusions (Osborne & Costello, 2004). During the first phase of recruitment three schools had responded and agreed to participate in the research. Perhaps this was a reflection of the timing of when I had sent out the recruitment e-mails. This was done early in the school year when heads of department are busy with professional development days, new classes, exams analysis and inducting new staff. These circumstances led to the re-evaluation of the study design.

I decided to refocus my approach. Rather than approach the study through comparing the two groups, namely the Science students and the non-Science students, instead I chose to focus solely on those who had opted to study the Sciences. I also decided to focus the subset of student selected for interviews on getting a range of backgrounds and experiences that would enrich the variety of the data; purposively sampling for different narratives. The results of the qualitative study would provide a new evidence base to develop a deeper understanding of the academic choices of a range of A-level Science students based on their insights and accounts. I made the decision to not include data from

other stakeholders because I wanted to explore the first-hand experience of students from their own perspective in keeping with my research questions.

Only students who studied at least one Science were given the questionnaire within the schools. Three schools returned questionnaires. Of the one hundred and fifty surveys distributed across three schools, there was a 63% return rate. Surveys were screened to ensure only those completed, and of Science, students remained in the sample; this left a return rate of 51% (76 students).

For the interviews, I used a purposive heterogeneous sampling technique to focus on particular population characteristics that were of interest, and that would best help me to explore my research questions. As I was working full time and needed to interview students during the school day and in some cases off-site, I decided to limit myself to twenty-two students from two of the schools for the interview stage. Fifty-two students volunteered to take part in this phase, and I had background information about them from their completed questionnaire. I used my literature review to focus on characteristics I chose to include both genders, range of different school's students had studied in, a variety of ethnicities, career aspirations, parental backgrounds and attitudes to Science. I am aware that my sample is not representative of the student population in the schools, let alone the local area. However, I chose my participants in an attempt to spread out the demographic characteristics of the sample while trying to capture a broad range of views about the process of A-level selection in this community. This sampling helped me to develop a deeper understanding of what participants think. As such, the goal was not necessarily to produce data that can be generalised to larger populations, but rather to explore the range of strategies, factors, and experiences held. The emphasis on the second stage of the study was not to look at the prevalence of the data amongst a larger population, but instead to explore the process of decision-making as a phenomenon (Lewis & Ritchie, 2003). As such it is not my aim to produce data which is generalisable to a wider population, as I used a purposive sample as opposed to a representative one. The data highlighted some intersubjectivity of the experience and was a tool for viewing the world as perceived by those selected students, so is useful in terms of transferability. A detailed description of the context of the study is included to allow reads to assess whether or not this research is transferable to others. Readers can then determine the

transferability of the findings and conclusions to other similar settings (Guba & Lincoln, 1989; Shenton, 2004).

### Context of the schools

Data was collected from students within three reputable non-selective, co-educational sixth forms. The schools offer a range of options for studying Science at GCSE, grades are comparatively higher at both A\*-C and A\*-A compared to the national average, and all three are oversubscribed. Student attainment at GCSE is relatively high compared to the UK national average schools. Attainment for GCSE Sciences for both the double award courses, as well as the separate Sciences is higher than the national average.

In all schools, the proportion of students attaining 5 A\*-C's including English and Mathematics for all three schools were significantly higher than the national average for England (59% in 2012). They had been consistently higher in comparison with percentages ranging from 70-76% in the year 2012. Two of the schools were both judged to be outstanding by Ofsted, and the other was judged to be good.

Data regarding the relative uptake of the Sciences compared to other subjects within the school was only available for two of the schools; these were the two schools that would be the focus of the interview phase. In one of the schools, Biology was the most popular Science, in fifth place, surpassed by psychology, mathematics, English literature and media; however, both Chemistry and Physics are in the ten (of twenty) least popular subjects with Physics in the lowest five. By contrast, in the other school, all the Sciences at A-level were in the top 6 most popular subjects, only significantly surpassed by mathematics and English literature. In addition to this at post 16, they had a significantly higher proportion of students choosing to study two or more facilitating subjects. These are subjects that allow students to keep their options open when selecting a university degree, as they are commonly required or preferred by university admission criteria. Regarding outcomes for students at Science A-level, students make at least good progress in both schools but in the school where Science was more popular students attained higher grades more consistently. In both schools, this was at least 10% higher than the national average for Science subjects. Results were consistently good with the proportion of

Physics and Biology grades at A\*-B in the mid-sixties, and Chemistry significantly higher in the high seventies.

One of the benefits of focusing on two schools for the second phase is that I could explore a wider range of complex dynamic interactions of people and events that led to a student choosing to pursue Science further in these two unique institutions. Placing my study in this local authority should allow me to explore a wider, richer range of student experiences and their perceptions of their educational choices.

### Structure of the questionnaire

The questionnaire (Appendix 3) was used to answer the first and second research questions, partially, and also as an aid for the sampling in the interviews. The survey followed a closed structure while allowing for some depth through layering. The questionnaire consisted of three sections, included 53 items and took respondents approximately fifteen minutes to complete.

The first section (pages 1 & 2) allowed for some background data to be collected on each student to enable links to be established in the analysis phase. This data included gender, ethnicity, syllabus studied, grades in Mathematics and Science as well as sources of information they used during the choice process.

The second section (pages 3 & 4) included some Likert statements (see table 4) related to values in society, self-concept in Science, desire to study Science and pursuing informal Science. The use of a Likert rating scale here was appropriate as it allowed me to build in some sensitivity into the students' responses (Oppenheim, 1998). According to Rodeghier (1996), the choice of a five-point scale is reasonably reliable. Rather than having an individual score for the attitude to Science, statements have been chosen to cover distinct attitudinal aims/areas and so a range of attitude scores can be seen.

Area explored	Statement associated with area
Value of Science in Society	<i>Advances in Science and technology usually bring social benefits</i> <i>Science is useful for further studies</i>
Self-concept of Science	<i>Science is useful to me</i> <i>I am good at Chemistry</i> <i>I am good at Biology</i> <i>I am good at Physics</i>
Desire to study Science	<i>I enjoy acquiring new knowledge in Science</i> <i>I would like to work in a career involving Science</i> <i>I would like to spend my life doing advanced Science</i> <i>The way Science is taught in lessons makes it interesting for me</i>
Pursuing informal Science	<i>I regularly watch television programmes about Science</i> <i>I regularly visit websites about Science</i> <i>I regularly borrow books on Science</i>

Table 4 Area explored by each Likert statement in questionnaire

A significant benefit of using a Likert type scale is its transparency, as its intention is often apparent to the respondent. None of the statements used on the Likert scale were negative, so the scale did not need to be reversed. This ran the risk of students faking responses, but there was no benefit to them doing so. To minimise this risk, students were told the purpose of this study and asked to answer these questions anonymously. Students were also informed that it had no impact on their educational experiences or attainment and that there would be no repercussions, whether positive or negative, for them (BSA, 2002).

In this section, students were also asked to share their career aspirations. The careers were organised into two groups; those that were Science-related and those that were not. A Science-related aspiration was one that directly related to Science, technology, engineering and mathematics, and which would often expect or usually involve one or more post-16 qualifications in a STEM subject. Examples included medicine and engineering but not accounting or a biological artist. To check that the codes were reliable I asked a colleague to do the same, and we were in 95% agreement.

<b>Area explored in third section</b>	<b>Statement associated with area</b>
<i>Science in school</i>	<i>Science lessons are among my favourite lessons</i> <i>When I have a choice after GCSE, I will choose at least one Science subject.</i> <i>What we do in Science lessons is useful whatever you do after you leave school.</i>
<i>Own interest in Science</i>	<i>I like watching Science programmes on the TV.</i> <i>I would trust something a scientist said.</i> <i>It would be good to have a job as a scientist.</i>
<i>Science and society</i>	<i>Science has a positive influence on society.</i> <i>Science makes an important contribution to the wealth of the nation.</i> <i>It is important for this country to have well-qualified scientists.</i> <i>People who do not know much Science are at a disadvantage in today's society.</i>

*Table 5 Area explored by each statement in section three of questionnaire*

For the third section (pages 5 to 10), I used an instrument developed by Bennett and Hogarth (2009) to explore attitudes to Science. The statements associated with each area explore are shown in Table 5. One advantage of this was that the instrument had been reviewed by experts within the field and had been used nationally. The first part of each item asks students whether they agree, disagree or are neutral about a statement. They then have to choose from preselected reasons for their position. There is an allowance for alternative reasons if they feel their reasoning is not covered. While open-ended questions may have been more sensitive to the richness of the student experience, this would have also involved time-consuming coding, which may have been less reliable than the closed approach. This structure also meant the questionnaire could take students less time to complete, have less of an emphasis on writing skills and reduce the number of questions that students may leave blank, thereby potentially increasing response rates. In addition to this, the researchers, Bennett and Hogarth (2009) proved reliability through conducting it twice, once with a free response and then three months later having generated fixed response options using students own responses. They found that there was an 85% overlap between using the instrument with its fixed responses compared to the initial questionnaire when it had used free responses. There is also ‘another reason’ box in each of the options so students could have added their own if they chose to.



At the end of the questionnaire, students had the option of leaving their contact details if they opted to volunteer for the next stage of the interview process.

### Structure of the Interviews

Eleven pre-selected questions within the interview schedule (Appendix 4), formed the backbone of each semi-structured interview. The first questions were used to identify the subjects the student was currently studying and to allow them to share their general perception of studying Science. The remaining questions focused on how the school, events, teachers, curriculum, school and people surrounding the students affected or supported their decision-making process. These factors were explicitly in the questions as they had been identified as factors within the literature review. There was also a question within the schedule which asked students to suggest why academically able friends may have chosen not to opt to study Science. This question was intended to give an opportunity for students to share less positive experiences that others or themselves may have experienced. Towards the end of the interview, students were given a chance to share anything else about the selection process and their decision-making. This question was intended to provide them with an opportunity to share other factors or experiences during the session that may have been missed. Each interview lasted approximately 20 minutes.

To keep the interview open and to allow for personalisation of the questions, I probed through asking follow-up questions and seeking clarification. In keeping with the nature of qualitative research, I did not strictly adhere to the pre-selected questions. Each interview was a unique social interaction and so even if I kept everything the same, then it may not be interpreted the same way. This factor is an advantage of qualitative research as there is more flexibility in the wording and the ordering of the questions which allowed for a deeper level of probing, the creation of a more natural and free-flowing conversation and enabled me as a researcher to check the participant's understanding of questions and concepts. It was impossible to eliminate my effect as an interviewer – but the key was to take this into account when interpreting the interviews. I thought carefully about the questions I asked and the atmosphere I created so that the interviewee could be as open

and honest as possible. As well as this I also reflected on how the social relations of the interviewee had shaped the data and kept this in mind during the analysis phase. To ensure I covered key areas in each interview, I typed the key questions onto a sheet, which I kept in clear view of the students throughout the interview. This action had the aim of encouraging students to focus on the question and to give them time to think about whether they had answered each one to their satisfaction.

### Credibility and authenticity

I have tried to address my potential bias by clarifying and explaining my choice of methodology, the background to my research and the reasons I was interested in pursuing it. By allowing the reader access to my qualified opinions, showing transparency in method and publishing full findings, as well as including a thorough discussion, I have raised a pertinent issue within the field, while not compromising the veracity of my research (Hammersley, 1990).

According to Altheide and Johnson (1994), validity represents the truthfulness of findings. In the context of this study, validity would depend on whether the research tools are appropriate to explore the research questions successfully, as this would, in turn, produce accurate data and inform the findings. Each part of the data collection has been mapped with a particular question, and I have explained my choice of each research tool in the discussion of methodology section. The instruments were planned to follow the advice from Bell (2005), which directly links the validity of a research project with the structure of the study. Bell states that ‘The structure of a piece of research determines the conclusions that can be drawn from it, and most importantly, the conclusions that should not be drawn from it (ibid: 118)’

I acknowledge that neither myself nor my study is value free. In fact, using the advice from Schwandt, Lincoln and Guba (2007), I recognise that there is always an intersubjective aspect of interpretation. As shared by Rouse ‘the investigator cannot help but always be situated relative to (and cannot escape) social circumstances such as a web of beliefs, practices, standpoints and the like, that he or she has learned as ways of living and grasping the world’ (1987 in Schwandt et al., 2007: 12). To keep the study both

credible and truthful in keeping with this approach I recognise this and also that interpretation is not an individual endeavour but a social and political one based on shared influences. As such I have tried to be free of any biasing influences and strived to use the interpretations to mirror reality. Logan and Skamp (2013) have shown that this can be planned for and taken into account by explicit personal and epistemological reflexivity and extended multimodal data gathering to attain reliability and validity. The conclusions may not be generalizable, but with my careful sampling and my choice of research methods, the results should at least be transferable.

To maintain the authenticity of this study my emphasis is on keeping it credible (legitimately truthful to the reality I interpret), transferable (to similar schools and individuals) and dependable (through the way it was conducted and analysed). Following in the footsteps of Erlandson (1993) I have written this section in the first person to acknowledge that I have ‘made choices in the course of the research that would have influenced what data were collected and reported, or not collected, and that the explanation that was finally offered was one that was unavoidably influenced to some extent by his or her (my) own worldviews (p. 262, Erlandson,1993).’

Due to the inductive nature of the qualitative aspect of the research methods employed, it is important that I also state my motivation for doing this research. I am a practitioner who has worked as a teacher for over 10 years. I was educated in an inner London school, I studied both Chemistry and Physics to A level and completed my undergraduate studies in Chemistry. I have experience of working in inner London as well as internationally and am interested in how factors come together to encourage or discourage an individual’s decision to study A levels in the Sciences. I opted to conduct research in my field of practice in order to inform my own practice and the practice of others through an increased understanding of subject selection narratives. I am aware that the field is rich with established research on factors that affect uptake of the Sciences, however, I feel practitioners could benefit from a framework that brings it together in a form that can be more easily understood and utilised to effect change. I intend to use this to be more effective at promoting the study of Science at A level, and to promote social justice, through ensuring that students who decide not to study Science have not been inadvertently discouraged or limited by factors outside of their control.

Reliability is the extent to which a test or procedure produces similar results under constant conditions on all occasions (Bell, 2005). In the questionnaire as well as using closed questions, I made every effort to structure all questions fairly to ensure that they were not leading. I did this so that the answers were not biased, and that they are an insight into what the student thinks or feels. To ensure that the questions were understood by the respondents clearly, I had them cross-checked by my supervisor, then trialled them with a random sample of year 11 students, to see if I needed to adapt them. I also used adapted instruments by other peer-reviewed and published researchers where possible. This increased face validity as well as internal validity.

Cargan (2007) highlights that 'respondents in questionnaires have greater feelings of anonymity and thus are more comfortable in expressing their real feelings on even personal or sensitive topics' (ibid:117). This suggests that the data is more likely to be valid and would accurately reflect student's perceptions. However, I was aware that when choosing questionnaires as a tool there was also a risk that students may just tick what they think I want them to say. This tendency is also a well-known theory in psychology called the desirability bias and is being researched in its own right (Podsakoff, Mackenzie, Lee & Podsakoff, 2003). I could not dismiss this entirely, but the use of the interviews alongside the questionnaire allowed for further probing to help identify and address this.

Reliability is not relevant in the second section of my approach. Although the results may not be reliable with the rigour required of a positivist approach, as it would be increasingly difficult to repeat the circumstances in which this research will take place, it is both credible and has the potential to be transferable for other professionals in the field. My research is context-bound as opposed to generalizable, and transferable as opposed to representative. This is a limitation but does not negate the dependability of the research project. One way I have demonstrated the validity of my findings is cumulatively through relating the conclusions from my study to the already existing concepts, literature and empirical research on educational choices and decision-making from other studies (Aronson, 1995; Sarantakos, 2012).

I recognise that I have a personal philosophy and that affect how I judge, criticise or endorse some of the evidence I come across. Realistically this means that just by running the research project, as I choose what data is to be collected and how it is to be analysed,

I have already imposed my personal philosophy on the research project. I have taken this into account, by following the advice of Dobbin, Gatowski, Ginsburg, Merlino, Dahir & Richardson (2001) in recognising, articulating and questioning the philosophy that I hold. Science is probabilistic, there is no right and wrong but there are different ways of looking at the data, and I recognise that I have made value judgements about what is admissible and what is not. In an attempt to recognise and eliminate my own bias, I have included detail for decisions I made so that the reader can understand my philosophy of 'truth' and scientific method and make their own judgements based on theirs.

There were other sources of bias that I needed to avoid according to Oppenheim (1998). These focused around sampling, rapport in the interview, biased probing, changes to the sequence of questions and selective interpretations of data as well as modifying the wording of the questions. The sample of students I selected for interview included a range of students from both genders and those who were studying a range of combinations of A-levels and had a range of careers suggested on their questionnaire, with a range of family backgrounds. This sampling helped me to create a wide-ranging sample that attempted to reflect the variety of possible narratives within the schools.

Another concern I had was about the selective interpretation and analysis of interviews to minimise my own bias, to avoid this and to improve the validity of my data, I asked students permission to audio record the interview and subsequently transcribed this. This helped to prevent me from missing out on comments I may not have recorded if I had waited until the end to summarise, and kept me open to listening for the unexpected responses I may have missed otherwise. In addition to this, I made a point of rewording key points and checking for clarification. I offered to share the transcribed interviews with students and provided them contact details in case they remembered something they wanted to share. The aim of offering the transcript was for students to check they were satisfied with the contents of the interview and if there was anything else they would like to add. This would potentially give students another opportunity to share more information that they may have thought about since the interview. No students took me up on this.

## Ethical considerations

It was important for me to think of the ethics from early in the research project and incorporate this into my planning because I was conducting researching within my own institution and the local area, as such I was putting myself in the dual role of teacher and researcher. Collection of data is an intrusion into respondent's life because of the time needed as well as the level of sensitivity of questions asked (Cohen et al., 2013; Alshenqeeti, 2014). As such, ethical considerations are needed at every level of the research project from initial approval from university to consent of schools and individual participants as well as collecting and processing data.

King's College ethical approval was granted, and the information sheets and consent forms are in Appendix 3. In accordance with the British Sociological Association (BSA) code of ethics, I needed to tangibly show respect for the participants of this study.

To achieve ethical approval, various aspects of the study that I needed to consider and incorporate. The first of these was the issue of access to the students and whose permission I needed to be able to approach students for interview. As a teacher in the local authority, in a position of responsibility and it was important that access to students was gained through the appropriate avenues, so that I did not abuse my authority and so that students did not feel compelled to participate if they did not wish to do so. The main gatekeepers I spoke to were the Heads of Science, as well as the head teachers. It was important to explain the rationale and focus of the study to them so that they gave their consent and so that it was evident the study did not seek to interfere with or undermine their respective roles.

To accomplish this, I initially sent an e-mail out to my head teacher outlining the primary objectives of the project including what I wanted to achieve, how long it would take and the implications on my teaching practice. Once I received approval for this, I then approached head teachers for the schools I wished to research, through e-mail. I followed these up with phone calls if this was not successful. For students in other schools, I spoke to teachers who were administering the questionnaires, about how to administer them and the target sample. I sent an email to sixth form tutors asking them to inform year 12

students about the study and to give them information sheets, containing a brief explanation of the study. The primary purpose of this part was to explain what the research project was about and to allow them access to further information or to opt out if they would like to do so. The information sheet was shared with the head teacher before being sent out. Within the next week, I gave out questionnaires to be filled out during the morning registration time, so as not to disrupt learning time. Once I had selected students for the interview phase of the study, I arranged to meet with them together to explain the study further as well as to give out information sheets and consent forms; and began arranging individual interview times with each student.

In addition to this, students who participated in the interviews were explicitly asked for their consent when arranging and before commencing the interview. It was also important that interviews were scheduled to minimise the impact of the research on the students' normal workload and took place in a neutral place which allowed for an open discussion, with minimal disruption. Students were also reassured that this project would not affect their grade in Science and that no prepping for the interview will be necessary.

To fulfil my responsibility towards participants, students remained anonymous to prevent any unforeseen repercussions for them in the future. For this reason, the study does not mention any individuals in an identifiable manner. Research data is in a secure location and, once anonymised the identifiable raw data collected was destroyed, and only the adapted anonymous versions were kept and used for analysis.

### **Analysing the questionnaires**

Completed survey forms were counted and checked. Questionnaires discarded included those that were incomplete or those that belonged to students who did not study at least one Science at A-level. Each survey form was assigned a number, and all the data inputted onto The Statistical Package for Social Sciences (SPSS) version 19. A range of descriptive and inferential testing was carried out on the data about subject choices.

Initially, descriptive statistics, in particular, the use of percentages and frequencies were used to gain some insight into the demographics and distribution of the respondents.

A range of inferential statistics was then used alongside the basic frequencies to see if there was a link between particular factors and specific subject choices. Odds ratios were used to look at the likelihood of studying different subjects depending on gender; this was appropriate as both sets of the data were nominal. Rank Biserial tests were used to look at whether GCSE attainment by subject correlated with choice of the subject at A-level, this was appropriate as it used interval and nominal data.

The intention was to use cross tabulation to look at how particular responses to Likert statements affected the total number of A-level Sciences studied or choice of a particular A-level subject. Then the use of chi squared could allow for identifying where the significant difference lies. In these cases, initially chi-squared values were calculated using raw data but for ease of reporting percentages were referred to throughout the analysis. The use of this was limited because of the relatively small sample size as in several cases less than 80% of the cells in the cross-tabulation contained 5 or more cases and so Spearman rank order was used instead. Spearman rank order correlations were used to look at the strength of effect sizes between ordinal and ratio data. Examples of this included the link between the number of A-level Sciences studied and responses to some of the Likert statements. Paired sample t-tests were used to look at whether there was a positive correlation between GCSE Science point score and number of A-level Sciences studies, as well as particular Science A-levels studied. This test was selected because the type of data analysed was interval and ratio, respectively. Each case was independent of the other and sets of data were normally distributed.

Interpretations of the strengths of the correlations and so effect size follow the suggested range within Cohen (1988) where a strong correlation is  $>0.5$ , moderate is between 0.3-0.5, and weak is between 0.1 to 0.3. The significance level was set at 0.05 critical value for all results.



## Analysing the interviews

To analyse the data in line with the conceptual framework chosen the process followed a particular sequence. The sequence is summarised in the flowchart (figure 4) and is discussed in more detail below, and in the analysis section.

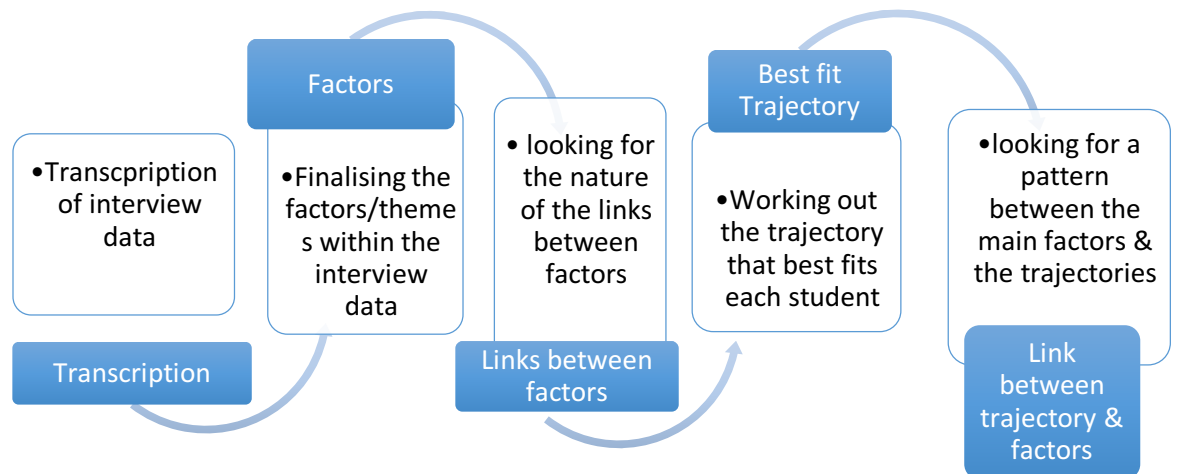


Figure 4 Sequence for the analysis of interviews

To analyse the interviews, I made an audio recording of all interviews which were subsequently transcribed and anonymised. When transcribing I knew I would not be analysing the scripts linguistically so I decided to naturalise the scripts by removing idiosyncratic elements of speech such as pauses, inaudible speech and stutters to allow me to focus on the content of the words themselves (Davidson, 2009; Oliver-Hoyo & Allen, 2005). The interviews were transcribed as soon as possible after the interviews themselves, and although this was time-consuming in a practical sense, this allowed for more valid data. I decided that transcribing the data word for word by myself would allow me to familiarise myself with the data and allow for fine-grained analysis (Dunne, Pryor & Yates, 2005; Pole & Lampard, 2002).

A thematic analysis of the transcribed interview data was conducted. According to Ryan and Bernard (2003) themes can be derived from the research data itself or guided by the existing theories in the field of study, with the possibility of moving beyond the anticipated themes in light of the new data. The literature review identified seven factors that affect a student's choices at A-level. Given the work I had already completed during

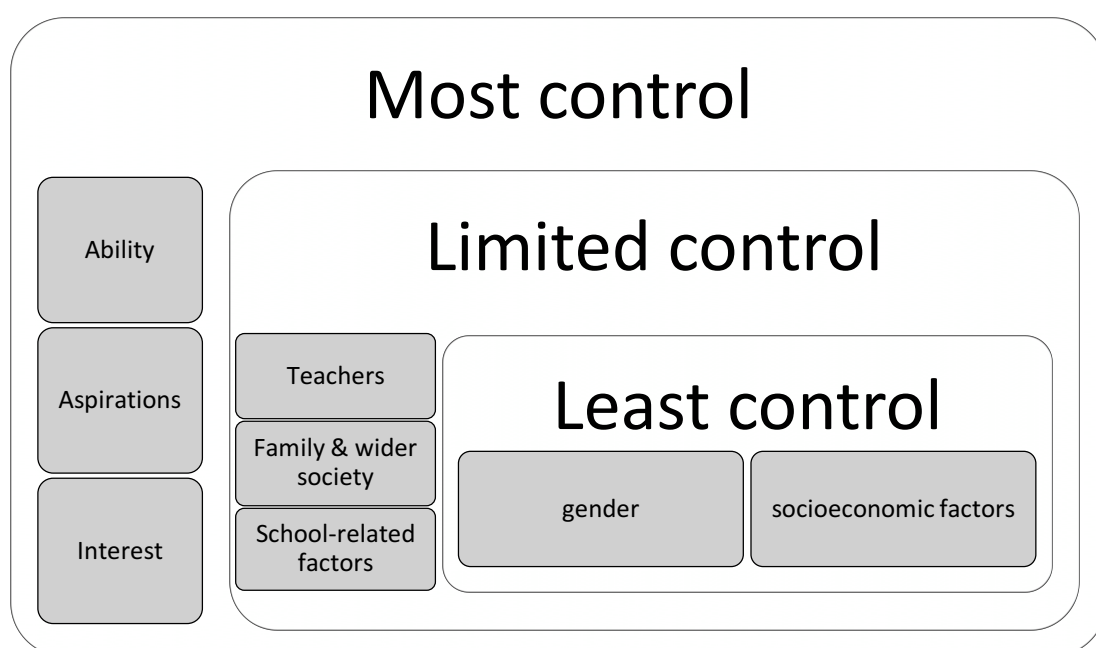
my Institute Focused Study on a smaller scale, I already had an idea of some of the key themes that may arise. These were included in the theoretical framework explained in the literature review. I made a decision not to include gender and socioeconomic factors as separate themes because they fit well within the other themes. I also decided to include teachers as a distinct category. Initially, I put the data into categories (Strauss & Corbin, 1990). These were ‘interest’, ‘ability’, ‘aspirations’, ‘teachers’, ‘school’, ‘family/peers’ and ‘reasons why friends had not opted to study Science’. I selected all comments or phrases relating to themes as identified, then reread these to detect any common sub-themes that were emerging. I then separated all comments into their relevant sub-themes. I tried to piece them together to work out what was being conveyed about the theme overall. This process allowed me to differentiate themes from each other and to identify dimensions specific to that theme (Corbin & Strauss, 2008). I chose to remove one of my initial themes about the reason friends had not chosen Science as I found that the issues that arose fitted more coherently into the other themes. Overall, I had refined the themes using data that emerged from the transcriptions and in light of my maturing understanding of the approach.



*Figure 5 Visual summary of the main themes and subthemes emerging from interview data.*

Appendix 6 includes an example of coding completed for an interview with Amy, using the final agreed themes. The final key themes are ‘personal interest in subject’, ‘aspirations’, ‘ability’, ‘school’, ‘teachers’, and ‘family & wider society’. Once all the comments about a theme were identified these were pasted into a word document. Then were grouped into sub-themes (see figure 5) to try to tease out what was being said by the students about each theme. An example of this is included in Appendix 7, and is related to the ability theme.

Following this, I looked at the themes above and arranged them into the three groups based on the student's control of each factor, as explained within the literature review. The initial framework, as originally shown in figure 1, needed to be edited slightly in keeping with the changes made as I analysed the data.



*Figure 6 Grouping of factors that emerged from interviews, based on degree of control of student*

The embedded nature of gender and socioeconomic factors within the limited control group remains and represent the embedded status they have with the other themes. The revised grouping is shown in figure 6. The ‘ability’ box has replaced the ‘attainment, self-concept and self-efficacy’. This box still represents all three aspects as experienced by the student. The aspirations box replaces ‘careers aspirations’ as it was clear from interview that aspirations were not limited to careers but also included further study.

Finally, attitudes to Science was replaced by 'interest' as it also involved skills and learning in general and because students were talking about all their subjects and not just Science. I also introduced 'teacher' theme as a separate box because there was a range of ways that they contributed distinctly and because in some cases their contribution was seen as separate from the school and wider society.

I used these grouping of themes by control to see if there were links between the factors. This stage included looking at the nature of the links between the different themes and how they contributed to the choice process.

In the final stage of the framework a best-fit approach was then used to work out which trajectories the students had followed. As such, it was important to read and reread transcripts looking for phrases or explanations that suggested certain trajectories. Finally, a link between the combination of factors and the trajectories students used was found and discussed.

## Analysis & findings of survey data

Surveys were used to collect data about students' beliefs and values about Science in society, as well as their perceptions of school Science. The sample analysed represented students from three schools. 62.7% of students (47 students) identified as being white-British, 11.9% (10 students) identified as being mixed, 9.2% (7 students) identified as being black or black British, 11.7% (9 students) as Asian or Asian British and 3.9% (3 students) as other. Eleven students had a parent with a Science background. In terms of gender, 47.4% were female (36 students), 48.7% were male (37 students), and three withheld their gender. 82.9 % of students in the sample chose to study Biology (63 students), 56.6% were studying Chemistry (43 students), and 27.6% were studying Physics (21 students), At GCSE 21% of the students studied towards a double award and 78% studied towards triple award Science. A table summarising student responses to questionnaire items is included in Appendix 5.

In terms of the number of A-level Science subjects studied, 31 students studied one, 40 studied two, and six studied all three. Of the 31 students studying only one Science, the majority, 23 students were studying Biology, followed by seven students studying Physics and one student studying Chemistry alone. This is summarised in the Venn diagram, in figure 7, below.

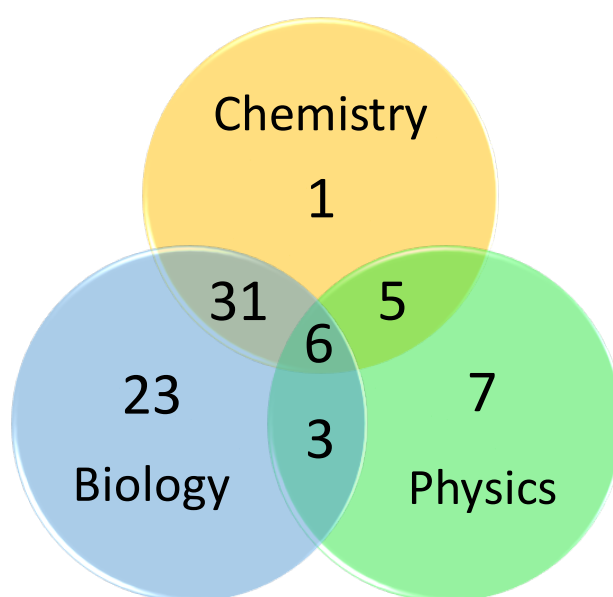


Figure 7 Venn diagram showing students Science subject combinations

There was a modest positive Spearman rank order correlation between the total number of A-levels studied, and study of A-level Physics ( $r=0.229$ ,  $p=0.046$ ) and a very strong correlation with A-level Chemistry ( $r=0.864$ ,  $p=0.000$ ). This finding suggests that students who were studying two or more A-levels were likely to have Chemistry as one of those and that Chemistry was unlikely to have been studied alone with only one student in the sample studying it as their sole Science A-level.

For statistical testing dummy coding was used, where a one was assigned to represent a student studying a particular subject, and a zero for those who were not studying it. The total number of Science A-levels for students were calculated as a sum of all three subjects, and the values ranged between one to three. The mean score for females for the total number of A-levels chosen ( $M=1.72$ ,  $SD=0.615$ ) did not differ significantly ( $t= -0.685$ ,  $df=71$ ) from that of the male students ( $M=1.62$ ,  $SD=0.635$ ). This means that within the sample there is not an overall difference between males and females in the number of A-level Sciences chosen. There was some finer detail within the individual choices that students made. The odds ratio shows that girls are 3.5 times more likely to take up Biology than boys ( $\exp(b)=3.462$ ,  $sp=0.011$ ) and four times less likely to take up Physics compared to boys ( $\exp(b)= 0.240$ ,  $sp=0.012$ ). Males were more likely to study Physics and less likely to study Biology. Chemistry did not show a gendered split.

Of the students, 83.2% had either decided on or had an idea for a future career, 50% of those who suggested a career named one that was Science-related. There were three different examination boards that students studied at GCSE, each of these has a slightly different emphasis on content and context but all award GCSE Science qualifications. The awarding bodies are Assessments and Qualifications Alliance (AQA), Oxford, Cambridge and RSA Examinations (OCR) and Edexcel. 53% of the students had studied AQA at GCSE with 42% having studied OCR and 5% who studied Edexcel. 20% of those students had studied double award Science, with the remaining 80% having studied three GCSEs in each of the separate Sciences. Students self-reported their GCSE grades with almost all students (two being the exception) having attained A\*-B in their Sciences and Mathematics GCSE's. Attainment at A-A\* in Biology was 92%, Chemistry was 89%, Physics at 82% with Core Science at 75% at grade A with no A\* grades and at Additional Science 81% attaining grade A-A\*. 21% of the sample had not supplied their GCSE

Mathematics grade –of those that did specify their grade, 75% had attained grades at A-A\*. Given the overall lack of difference between proportions of both genders, attainment at GCSE Science, geographical location, borough, and the uptake of A-level Sciences, I collapsed the reporting of data in terms of school and gender, except in certain circumstances which are highlighted in the findings.

### Experience within school Science

Students who achieved higher on average at GCSE were more likely to take a higher number of A-levels in the Sciences. Using a paired sample correlation test it was clear that there was a modest positive correlation between students' average point score in their Science GCSEs and the total number of A-level Sciences they chose to study ( $r=0.421$ ,  $p=0.000$ ). There was also a positive correlation between average GCSE Science point score and the uptake of Chemistry at A-level ( $r=0.405$ ,  $p=0.000$ ) and Biology ( $r=0.384$ ,  $p=0.000$ ) but not for Physics ( $r=0.149$ ,  $p=0.174$ ).

As the majority of the sample had followed a triple Science course at GCSE, a rank biserial test was done looking at students' subject choices, against their attainment in that subject at GCSE, i.e. whether they chose Biology A-level and their GCSE Biology grade. Although statistically significant, the effect size was modest for Biology ( $r=0.258$ ,  $p=0.048$ ), but moderate for Chemistry ( $r=0.450$ ,  $p=0.000$ ).

Rank biserial correlations showed a strong positive correlation where students who chose to study A-level Chemistry were more likely to study a higher number of A-level Sciences ( $r=0.867$ ,  $p=0.000$ ). It also showed that there was a strongly negative correlation between students who chose to study Biology and Physics ( $r=-0.657$ ,  $p=0.000$ ). Students who studied Physics were less likely to be studying Biology as well.

Of the students, 68% agreed with the statement 'what we do in Science lessons is useful whatever you do after you leave school.' Only 58% of students agreed with the statement 'the way Science is taught in lessons makes it interesting for me'; 12% disagreed with this with the remaining students neither agreeing nor disagreeing.

Regarding students' experience of Science in lessons, 67% of students agreed that at GCSE, Science lessons were among their favourite lessons. 28% were neutral about this. A cross-tabulation of the total number of A-level Sciences studied against the item shows the distribution of responses. Within Table 6, the 5 point Likert scale has been collapsed to 3 to display the results more clearly. The breakdown within the table suggests that those who disagreed or are indifferent are more likely to study a lower number of A-levels. Using the detail in table 6, alongside a Spearman rank order correlation strengthens this conclusion.

		Total number of Science A-levels studied by the student			Total number of students
		1	2	3	
GCSE Science lessons were among my favourite lessons	Disagree	3	1	0	4
	Indifferent	14	7	0	21
	Agree	14	31	6	51
Total		31	39	6	76

*Table 6 Cross tabulation of GCSE Science lessons were among my favourite lessons against total number of Science A-level Science studied.*

Spearman rank order correlation showed that there was a moderately positive correlation between students who agreed with this statement and the total number of A-level subjects studied ( $r=0.404$ ,  $p=0.000$ ). Agreement with that item also showed a modestly positive correlation with students who chose to study Physics ( $r=0.252$ ,  $p=0.028$ ) and Chemistry ( $r=0.349$ ,  $p=0.002$ ).

### Own interest in Science

Of the students, 94% enjoy acquiring new knowledge in Science with 86% of students agreeing that Science was useful to them. Students who were more likely to agree with the latter statement showed a moderately positive correlation with the total number of A-levels studied ( $r=0.268$ ,  $p=0.020$ ).

The most popular display of students personally pursuing Science involved the television, with 58% agreeing with the statement 'I like watching Science programmes on the TV' and 46% of students agreeing that they 'regularly watch television programmes about Science'.



Of the students, 21% claimed they regularly visit websites about Science, with 45% stating they do not. Literature was also not popular, with only 20% of students claiming they regularly borrow books on Science, with an overwhelming 56% of students stating that they do not. Students who were more likely to agree with the above two statements were more likely to choose to study Chemistry and also more likely to study a higher number of Science A-levels. The data is shown in table 7 below.

Statement	Study of Chemistry			Total number of Science A-levels studied by student		
	r	$\rho$	N	r	$\rho$	N
I regularly visit websites about Science	0.259	0.024	76	0.280	0.014	76
I regularly borrow books on Science	0.311	0.006	76	0.332	0.003	76

*Table 7 Correlation between visiting websites and borrowing books on Science and study of Chemistry and total number of Science A-level Science studied.*

Of the students, 60% agreed ‘it would be good to have a job as a scientist’, with seven students stating they did not know what a scientist does and 17 students sharing that it would depend on what the job was. There was a moderately positive correlation between students who agreed it would be good to have a job as a scientist and those who had chosen to study A-level Chemistry ( $r=0.289$ ,  $p=0.012$ ).

Regarding career and further study, 68% of students would like to work in a career involving Science, 37% of students would like to spend their life doing advanced Science, as well as 89% of students agreeing that Science is useful for further studies. Two of these statements correlated moderately with both the study of Chemistry and the total number of Science A-levels studied, as in table 8 below.

Statement	Study of Chemistry			Total number of Science A-levels by student		
	r	$\rho$	N	r	$\rho$	N
I would like to work in a career involving Science	0.527	0.000	76	0.534	0.000	76
I would like to spend my life doing advanced Science	0.433	0.000	76	0.498	0.000	76

*Table 8 Correlation between aspiring to careers involving Science and study of Chemistry and total number of Science A-level Science studied.*

More than half of the students studying Chemistry were more likely to have agreed with the statement ‘I would like to spend my life doing advanced Science’ and ‘I would like to work in a career involving Science.’

When asked whether they had decided with regards to a career, 17% shared that they had not, while 42% had and a further 40% stating they had an idea. 68% of the students filled in the section where they shared their career aspirations. These were sorted into two groups; those that were Science-related and those that were not. 47% (25) of the students who filled in a career idea had Science-related career aspirations. A cross-tabulation of the total number of A-levels studied against whether students were considering Science-related careers, in table 9 below, shows that the majority of the students who had decided on a Science-related career were studying at least two Sciences, with those studying one not considering a Science-related career. A Spearman's rank order correlation for the 51 students who had decided on a career with the total number of Science A-levels chosen against Science-related career showed a positive correlation ( $r=0.543$ ,  $p=0.000$ ).

		Total number of Science A-levels studied by student			Total number of students
		1	2	3	
Science-related career?	No	17	5	3	25
	Maybe	1	0	0	1
	Yes	1	22	3	26
Total		19	27	6	52

*Table 9 Cross tabulation of aspirations for a Science-related career against total number of Science A-level Science studied.*

Students had the highest confidence in Biology where 80% of students felt that they were good at it while only 4% of students identified themselves as not being good at Biology. Chemistry showed a similar trend with 63% of students agreeing that they are good at Chemistry while 16% of students claimed that they were not good at Chemistry. In Physics, 49% of students agree that they are good at Physics, with 21% claiming they are not good at Physics. Interestingly the highest proportion of neutrality when it came to confidence was in Physics with 30% not making a claim, either way, this is compared to 22% in Chemistry and 16% in Biology.

There was a difference in subject confidence found between genders for Physics with 67% of males agreeing or strongly agreeing with the statement ‘I am good at Physics’ compared to 33% of females. Students who identified as being good at a subject showed

a positive correlation with taking up that subject at A-level. The strength of the Spearman rank-order correlations varied with a modest correlation for Biology ( $r=0.309$ ,  $p=0.007$ ), followed by moderate correlations in Chemistry ( $r=0.450$ ,  $p=0.000$ ) and Physics ( $r=0.467$ ,  $p=0.000$ ). Perhaps for Biology, this was affected more by gender, given that there was a higher proportion of females taking Biology. Confidence in Chemistry was the only one of these positively correlated to the total number of Science A-levels ( $r=0.367$ ,  $p=0.001$ ).

### Science in Society

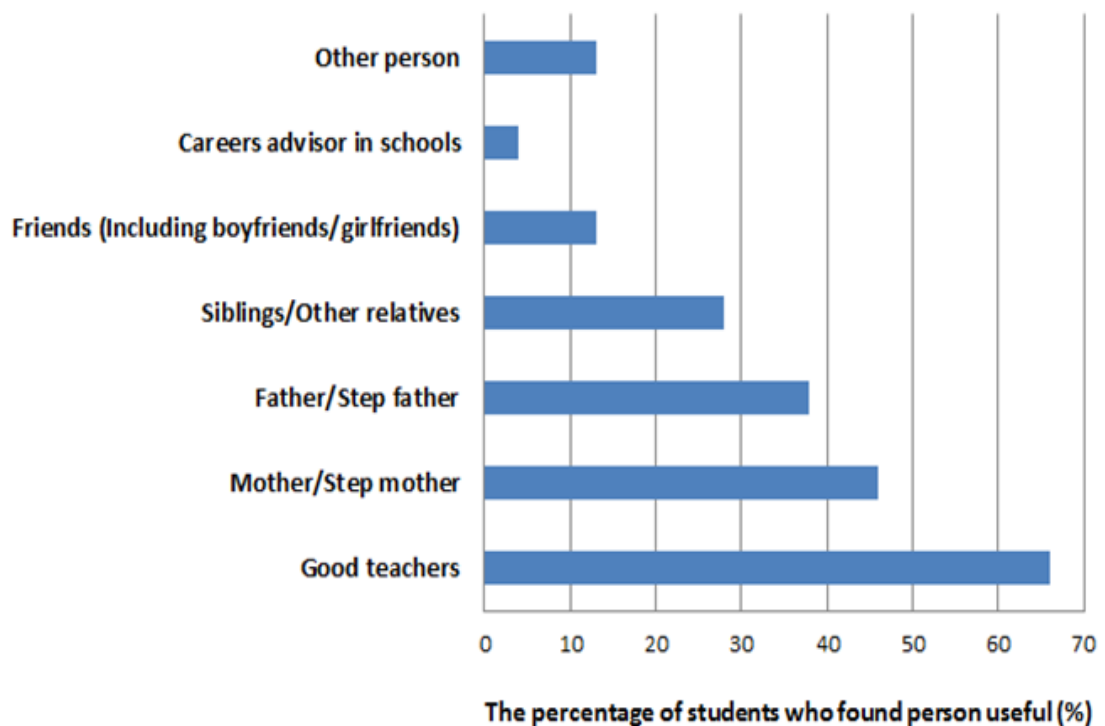
Student attitudes to Science and society were positive with 84% agreeing that Science has a positive influence on society and no students disagreeing with this statement. 72% of students agreed that Science makes an important contribution to the wealth of the nation. An overwhelming 92% agreed that it is important for this country to have well-qualified scientists, with 65% relating this to the need for development in areas such as medicine, and 15% linking this to a need for governments to make the right decisions on issues such as the environment. 24% responded to say they would trust something a scientist said, 70% neither agreed nor disagreed the majority sharing that it would depend on who the scientist was – this proportion might be overly high as that was the only prompt given in the question for a potential reason. There was an option for students to write their own reason, but there may have been a tendency to agree, as that was simpler. 55% of students felt that people who do not know much Science are at a disadvantage in today's society; 33% of the total sample had agreed with this because they felt that these people would not be able to understand things you see on the news or in the papers. It is interesting that 33% did not feel that knowing Science made much of a difference in today's society. Both students who opted to study Chemistry ( $r=0.257$ ,  $p=0.028$ ) and those who studied Physics ( $r=0.256$ ,  $p=0.029$ ) showed modest Spearman rank order correlation with another statement where 84% of students agreed that advances in Science and technology usually bring social benefits. This statement also correlated modestly with the total number of Science A-levels studied ( $r=0.309$ ,  $p=0.008$ ). No other correlations between studying Biology or Chemistry and agreement with the above statements were significant.

## The decision-making process

All students in the sample were studying at least one Science subject when they had a choice for A-level. Looking at the spread of reasons 37% of the students said this was because they needed it for the job they wanted to do, while 22% chose it because they enjoyed it at GCSE. Two female students ticked 'other' and wrote that it was because their parents wanted them to.

When students were asked when they reached their decision about their A-level subjects, 12% had made their decision before entering year 11, while the majority, 67%, made their decision during year 11, with a further 15% making their decision on results day. Three students (4%) had reached their decision in year 7 with only one stating she had decided in year 6 or before.

When asked what, they found helpful when deciding on their A-level options; students were asked how important each person was in choosing their courses and were asked to select on a Likert scale from not very important to very important. To process this in a way that was useful, I chose to merge important with very important and tabulate the percentage of students who benefitted from the person. The most popular choices were good teachers, at 66%, with family featuring as important with mother, 46%, followed by father, 38% then siblings and/relatives at 28%. The least popular appeared to be careers advisors, 4%, and friends, 13%. Five students selected other as an option with four of them identifying themselves and one listing her counsellor. The findings are summarised in figure 8 below.



*Figure 8 Graph showing the percentage of students who found each person useful.*

Students were offered a range of factors that may have affected their decision at A-level and were asked to rate them from not very important to very important on a five-point scale. In retrospect, the wording of ‘not very important’ may have suggested a range of perceptions ranging from very unimportant to some to moderately unimportant to others. As such, I decided to merge the categories of not important and not very important to take this into account in the summary below and renamed this as unimportant.

Interest in the subject was almost unanimously agreed to be very important with 75% of students saying it was very important and a further 21% saying it was important. Previous attainment followed this trend but to a lesser degree with 59% of students stating it was important, and a further 32% suggesting it was very important. Another influential experience appeared to be the students’ research on subject choices with 59% stating this was important or very important and 21% of students reporting it was unimportant.

The importance of experimental and lab work in choosing their course was considered unimportant for 36% of students, with 42% undecided. Fieldwork was seen as even less important with 51% of students saying it was unimportant, a further 32% undecided and only 17% considering it at least important. Another experience was clear feedback on

whether they had got a right answer; this was rated as important or very important by 76% of students, with 14% undecided and a further 9% who felt that it was unimportant.

Two statements showed a similar split between those who considered it important and those who did not. 37% of students said using mathematics in lessons was unimportant compared to 33% who considered it important. Showing the relevance of the subject to society where 35% of students considered it unimportant, with a similar 38% of students suggesting it was important or very important. However, when a similarly themed statement referred to the practical applications of the subject 54% of the sample stated it was important or very important, with 26% of students' undecided.

The least influential experience appeared to be going to a careers fair which was important or very important to 8% of the students, with 19% undecided, with the majority proportion of 73% stating that this was unimportant. Another experience that seemed to be not very influential was that of an online careers aptitude test with 75% stating it was unimportant and a small minority of 7% stating it was important for them.

Work experience was identified as being unimportant to 54% of students while 26% did find this important. Taster days were popular with 56% of students sharing they had found this experience important compared to 25% who did not and the rest undecided. This was not entirely consistent with the views shared within interviews, with far less positive comments about the experience made.

Inherently within the support structure, some techniques or experiences will be more useful to some students than others, and knowing that others may not have benefitted does not negate a useful experience for other students. With this in mind, I merged important with very important and ranked these experiences according to the percentage of students who had found this useful. Patterns emerged when examining the more popular type of experiences that students agreed were important in choosing their course.

Experience	Students who agreed this school experience was important in choosing their course (%)
Your interest in the subject	95
Your previous attainment in related subjects	88
Clear feedback on whether you got the right answer	76
Researching on your own	59
Lessons showing practical applications of your subject	55
Taster sessions	55
Lessons showing the relevance of your subject to society	37
Using mathematics in lessons	33
Work experience placement	25
Experiments/laboratory work	22
Field work or trips	17
Going to a careers fair	8
Doing an online careers aptitude test	7

*Table 10 Percentage of students who agreed with each school experience being important to their course choices.*

It is particularly interesting that four of the most popular six experiences are those present in the day to day experience of the subject as part of a student's regular schooling. These experiences include being interested in the subject, attainment, the feedback they receive (presumably from a teacher or peer) and day to day lessons with applications of their subject. The remaining two that lie outside students' everyday experience is personal research by the students and an opportunity to experience what the daily experience of the subject might be like at A-level. The most popular directed support the schools deliver in the options process appears to be taster sessions with just over half of students finding them important. Within the classroom, using mathematics in lessons was rated more highly than experiments and laboratory work. Enrichment activities appear to be much less useful with work experience placements, trips and careers fairs important to a smaller proportion of students. The above factors were explored further during the interview phase.

## Summary of main findings of survey data

Data from the surveys, suggest that there is a range of factors that correlate with the number of A-level Sciences studied. While these correlations are not causal, they do show links between the factors. Table 11 shows these correlations and displays a measure of the hierarchy of which individual factors are linked to the variable in question.

Strong correlation (>0.5)	Moderate correlation (0.3-0.5)	Weak correlation (0.1 - 0.3)
<ul style="list-style-type: none"> <li>• studying Chemistry (0.864)</li> <li>• aspired towards a Science-related career (0.543)</li> <li>• would like a career involving Science (0.527)</li> </ul>	<ul style="list-style-type: none"> <li>• would like to spend life doing advanced Science (0.433)</li> <li>• average GCSE Science point score (0.421)</li> <li>• At GCSE Science amongst favourite lessons (0.404)</li> <li>• good at Chemistry (0.367)</li> <li>• regularly borrow books on Science (0.332)</li> <li>• believe that advances in Science and technology bring about social benefit (0.309)</li> </ul>	<ul style="list-style-type: none"> <li>• regularly visit websites about Science (0.280)</li> <li>• enjoy acquiring new knowledge in Science (0.268)</li> <li>• studying Physics (0.229)</li> </ul>

*Table 11 Variables that positively correlate with number of Science A-levels studied.*

The strongest correlations showed that students were most likely to be studying a higher number of Science A-levels if they studied Chemistry as one of their choices, and had Science-related career aspirations. The reasoning behind why students pick Chemistry more frequently as part of their combination of A-level Sciences will be explored further during the interview phase.



Moderate correlations confirmed the link between the number of A-level Sciences studied and career with students who would like to spend their lives doing advanced Science studying more A-level Sciences. In addition to this other factors that showed a similar correlation to attainment at GCSE, their enjoyment of Science lessons and their belief that they were good at Chemistry also had moderate correlations. Other moderate correlations were found with those that regularly borrowed books on Science and held the belief that advances in Science and technology brought about social benefits. Weak but never the less significant correlations were also found with those that regularly visited websites about Science, enjoyed acquiring new knowledge and those that studied an A-level in Physics. During the second, interview, phase the combination of these factors and how they link with each other was explored through the trajectory framework to see how they have affected the overall decision-making process.

Although there was no significant gendered difference between the number of Science A-levels studied, the data showed variation within subjects. Equal proportions of boys and girls studied Chemistry, but 3.5 times more girls studied Biology and four times fewer girls studied Physics compared to boys. There was also a strong negative correlation between students who studied Physics and those who study Biology, with students unlikely to study both.

There was a gendered difference found in subject confidence for Physics, with boys more likely to agree that they are good at Physics compared to girls. Students confidence in a subject was correlated with uptake of the subject and showed that those who identified as being good at a subject showed a positive correlation with taking up that subject at A-level. The correlation was more modest for Biology (0.309) but stronger for Chemistry (0.450) and Physics (0.467).

With regards to timing, the majority of students stated they had made their decision during year 11, with one in six reporting they made their decision on GCSE results day. When asked who they found helpful when deciding on their A-level options, most popular choices were good teachers and members of the student's immediate family (in the order of mother, father, siblings then other relatives). The least popular appeared to be careers advisors, who were rated less helpful than friends. Although this data is useful in seeing the hierarchy of who was found helpful when making this decision it does not show depth

as to how individual people were useful in the process. For example, did they help with generic advice about how to approach decision-making, or were they more helpful regarding insights into potential study pathways or was it careers advice. These questions were explored further with students at the interview phase.

When asked to identify factors that were influential in their career decisions, students shared that of the most important was their interest in the subject, prior attainment, own personal research on subject choices, taster days, lessons showing the practical applications of the subject and clear feedback on whether they had got the right answer. The least important factors were going to a career fair, doing an online careers aptitude test, experimental and lab work and fieldwork. Together the information from the survey suggests that while career aspirations appear amongst the strongest of the correlations neither careers advisors or careers aptitude tests or careers fairs feature as influential in terms of the student perceptions. These are issues that are explored further at interview.

## Analysis & findings of interviews

In keeping with the model chosen in the methodology, this analysis focuses on several features. Within this chapter, there is an overall summary of the trajectories that students have used to make their decision regarding A-level choices first, this serves as an overview. Secondly, there is an explanation of the individual factors that students mention that have affected the students. Finally, the links between the factors are made, and then the relationship between the factors and the overall trajectories are discussed. There is a summary of the five trajectories in table 12 below. The presentation order has differed from the order of analysis to give a more reasoned and staged argument overall.

<b>Trajectory</b>	<b>Brief explanation</b>
Direct	Where a student has a high visibility occupation or career in mind; these students had the most stable subject commitment
Partially resolved	A student has not necessarily chosen a career but was aware of the usefulness of their subject choices for future careers
Funnelling identifier	A student who narrowed their choices over time
Multiple-projection	A student who continually changed their minds about their subject choices
Precipitating	A student who based their choices on wider interests or skills, without a careers focus

*Table 12 Brief explanation of each trajectory*

As phase two involved a purposive sample, the results below are not representative of the student population. Students interviewed were selected, based on a maximum variation in the potential range of narratives. I decided to include students from both genders, from a variety of different schools, ethnicities, career aspirations, parental backgrounds and attitudes to Science.

Although I was able to identify the main trajectory that each student followed, I was aware that some students did not follow the same trajectory for all of their subjects. For example, some students had a core of three subjects they wanted to study and an additional fourth subject that they were more flexible about because it did not necessarily directly impact

their future. In this case, a student could theoretically choose the first three subjects based on a direct trajectory and choose their fourth subject using a different trajectory.

In order to identify the trajectories a student used, I read and reread their interview transcript several times. Reading Amy's transcript (Appendix 6) allowed me to identify that she is inclined towards medical/biomedicine but not engineering. She does enjoy the Sciences, but shares that she chose her A levels based on her career prospects. As such she appears to be following a partially resolved trajectory where she has not necessarily chosen a career or a university degree but is aware of the usefulness of her subjects for future study and careers.

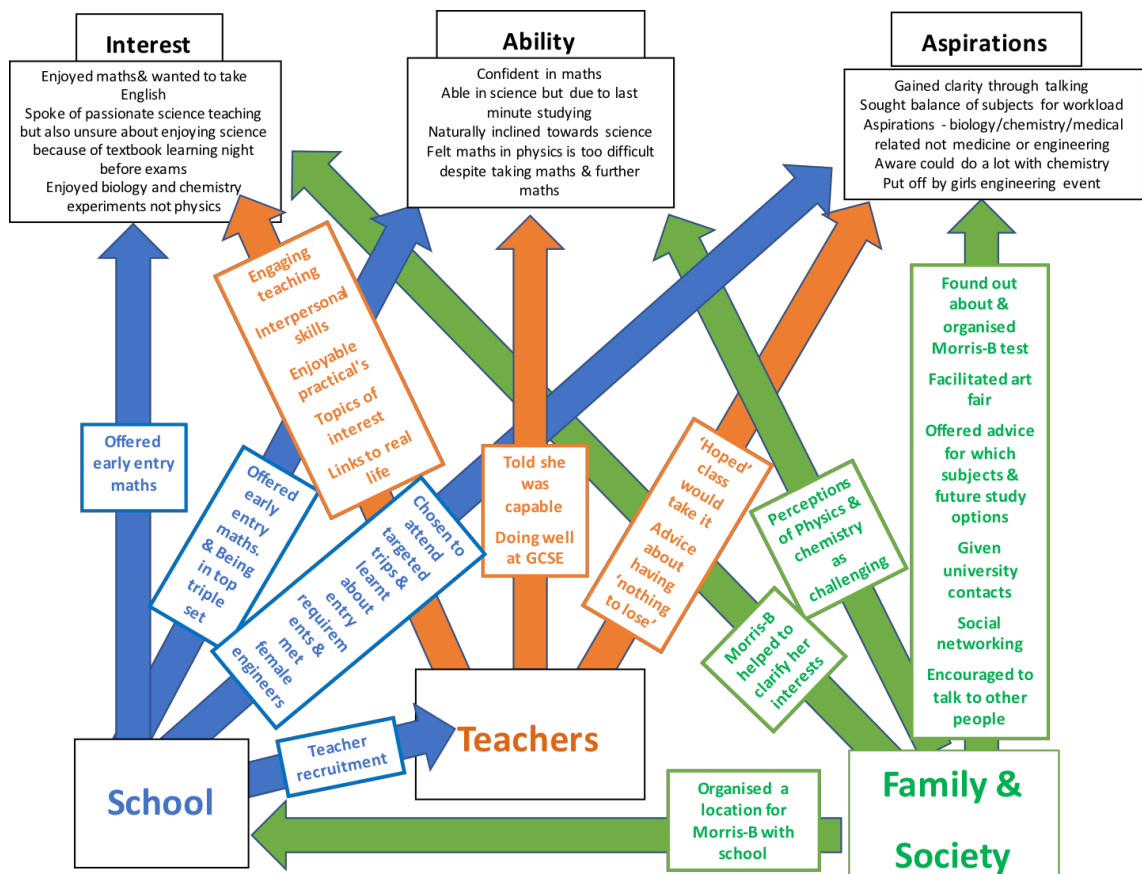


Figure 9 Links between Amy's themes

Looking at figure 9 it is clear that the school, teachers and family and wider society contributed to Amy's interest, ability and aspirations. Her parents helped her clarify her interests through facilitating a Morris-B test and a careers service, her teachers made lessons engaging through content and interpersonal skills, as well as adding applications

to real life. Her school facilitated her teachers, offered her early entry in maths which she states she enjoyed. Her confidence in her ability was built through early success in maths, being placed in top set and triple Science and doing well in her GCSEs. In terms of her aspirations and future studies she was selected for a targeted trip by her school where she interacted with engineering students, learnt about entry requirements and met females from her field. Her teachers gave her strategy advice in terms of option choices and how many to choose and her family and wider society facilitated the Morris-B test which offered personalised guidance on suitability for courses, access to an art fair, social networking and contact details for university. Overall she is clearly interested and confident in her ability to study the subjects she has chosen and each theme has contributed uniquely to others. She has chosen the subjects she has because she knows they are useful, and because at one stage she was considering medicine. This means she may have one stage been following a direct trajectory but as she is undecided on a career she is on a partially resolved trajectory. She has congruence between her ability, interest and aspiration but has not settled on a career choice, because of this she does not fall into the direct trajectory.

Summarised below are further summary examples from the data for each trajectory.

### ***Direct trajectory***

*Subject choices: Biology, Chemistry, History, Maths and Further Maths.*

Timothy wants to be a doctor because he feels that it suits him as a person, in terms of, personality and strengths. He looked up university entry requirements and knew that Chemistry was compulsory as well as at least one other Science. Timothy chose Biology over Physics because Physics was not his strongest subject at the time. He was good at maths and thought that universities would look on it favourably, so he chose that too. Timothy also chose history because it will make him seem like a more well-rounded person and would show he could do essay writing. Timothy choices are focused on what he wants to be when he grows up as well as his strengths and what studying each of the subjects will show about him as a student.

### ***Partially resolved trajectory***

*Subject choices: Chemistry, Maths, Psychology and Physics*

Gareth was not sure which courses he wanted to study at university but was considering engineering and computer programming or similar. He looked up entry requirements for university courses he might be interested in, and the courses were based on maths and Physics, so he chose them. He was also interested in psychology because he had spoken to friends who have studied it at GCSE and enjoyed it. For his fourth subject, he narrowed down between further maths and Chemistry. He felt that as Physics was very maths based too, it would be better to choose Chemistry as part of the combination to not narrow down his options completely. He actively looked at keeping his options open until the time came when he then had to choose. It was then he would do what he wants to do. Gareth's choices show an awareness of the usefulness of his subject selection for future study and careers, but he has not chosen a career or university course.

### ***Funnelling identifier trajectory***

*Subject choices: Maths, Physics, product design and Spanish*

Lucas felt he was skilled in drawing and art and had a logical mind. At GCSE he chose to study Art but felt he needed more structure as he wanted to work to more specified briefs, so for A-level, he chose product design. This then led to him thinking about engineering as an option, and Lucas enjoyed Science and was good at it so decided to do Physics and maths too. Looking back, he says that Physics and maths were his core subjects. He added Spanish in as a choice because he was good at it and had got an A\* at GCSE, but would drop it at AS. In terms of career Lucas could still go into design or engineering but feels he has the subject combination to enable both.

### ***Multiple-projection trajectory***

*Subject choices; Biology, Chemistry, Sociology and Psychology*

Shaniqua had initially wanted to study media; she had discussed this with a careers advisor. She had also considered BTEC in health and social care as an avenue into nursing. After considering personal happiness and future financial stability, Shaniqua changed her mind and decided that she wanted to study for Biomedical Sciences in year 11. She checked university entry requirements and knew she needed Biology and Chemistry. AS well as this she was interested in them as

subjects and enjoyed them, so she chose them. She was also interested in psychology and sociology and did well at them in GCSE so chose them too.

***Precipitating trajectory***

*Subject choices: Maths, Chemistry, Biology and Geography.*

Nathan does not know what he wants to study at university or what he wants to be when he is older. He chose maths because he has been good at it and enjoys finishing a question. Nathan chose Chemistry because as it got harder, he found it more interesting. He enjoyed the nature of the subject content in Biology and geography he chose as a space filler. He knew he was good at it at GCSE and could do well at A-level.

***Mainly a direct trajectory with some multiple-projection***

*Subject choice: Biology, Chemistry, Sociology and Psychology*

Twii has wanted to be a marine biologist since she was in year 9. She picked subjects she enjoyed that would help her to become that and that she could excel in. She guessed that she would need Biology and Chemistry. For her remaining options, she remained flexible and chose different ones for each sixth form application. In the end, she chose sociology and psychology, but she had changed these for history or classical heritage depending on the options available at different institutions. Twii has used a direct trajectory for two of her options; she has also shown aspects of a multiple-projection trajectory for the remaining two.

***Mainly a direct trajectory with some precipitating***

*Subject choices: Physics, Biology, Chemistry and philosophy*

Ella is an aspiring vet; she has wanted to do this since she was in year 7. She researched entry requirements and knew she needed both Biology and Chemistry, with either maths or Physics. She chose Physics over maths because she was good at it and although Ella did not enjoy Physics in school, she had done extra research outside of school and found it more interesting. Her maths teacher had questioned how well she might do on an A-level Science course., though she felt she probably would have been fine. Ella chose philosophy on the recommendation of her religious studies teacher because she enjoyed it and was interested in learning more about it. Although she wanted to be a vet, she was aware of how competitive it was and knew she could use this combination to apply for biomedicine or Biochemistry too. Two of her A-level choices were based on direct trajectory, and

the remaining two used a precipitating trajectory using a combination of factors including interest and enjoyment of the subject and teacher recommendations.

An analysis of the trajectories in use shows that the vast majority, sixteen of the twenty-two students interviewed across both schools followed a direct or partially resolved trajectory where they had either decided on a future career or were aware of the usefulness of their subject regarding careers or further study. For many of these students, this informed the majority of their A-level subject choices. As such, they had strong subject commitment. Three students followed a precipitating trajectory; this is a path where students based their A-level choices on what they enjoyed and found more interesting overall. These students had not decided on any preferences for university study or future careers. Of the remaining three students, one followed a funnelling identifier trajectory where he had a vision for what he wanted to do but adapted it over time to a similar field with a higher chance of success. The remaining two students followed a multiple-trajectory approach where they changed their minds about their careers. Finer details of how each theme and trajectory affected these students are in the following sections.

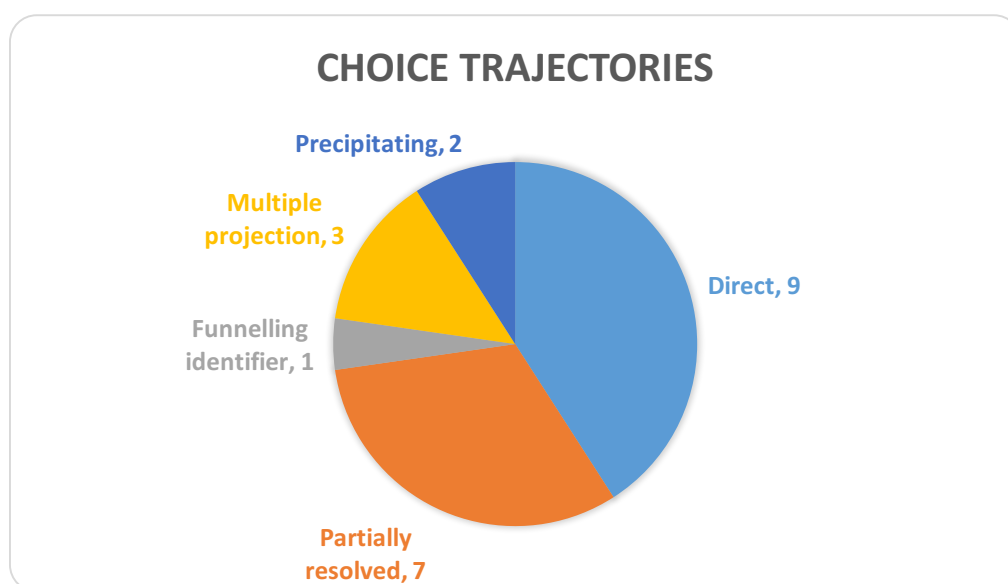


Figure 10 Pie chart summarising the proportion of students who used each trajectory.

As well as analysing the interviews for trajectories, the audio recordings of the interviews had been transcribed and coded according to the themes explained within the



methodology, and these are analysed below. Through the interviews, students shared their views on themes including their interests, aspirations, ability, school experience, teachers and other people retrospectively. The unique combination and factors of these aspects together affected each student differently.

Reading through the trajectories and the interview accounts of students it was clear that it is the combination of the following themes, discussed below, that interrelate and allow students to reach their decisions. Using a trajectory framework makes it possible to appreciate how the student's value and view of each of these themes can vary for individual students, for each subject and as such they are discussed in greater detail below.

For the next stage of the analysis all phrases students used about a particular theme were collated then organised into sub-themes and these were used to illicit meaning and find out how each theme contributed to a student's overall subject choices. An example of Amy's coded interview transcript and of the collated statements for ability are in Appendices 6 and 7.

### **Personal interest**

All students mentioned their interest in subjects during their interviews. For three students, this was a driving factor, as they had followed a precipitating trajectory where they based their A-level choices mainly on interests or skills. These three students had not yet decided what to study at university level or what to pursue as a career.

The range of comments referring to interest indicated clear that students did not only choose the subjects they enjoyed and avoid those they did not. Other subtle nuances contributed to student interest and are discussed below.

Students gauged and explained their level of interest through a variety of means. There were some who compared their level of interest between subjects, others who took into account how long they had enjoyed the subject, whether they pursued it voluntarily outside of the classroom or wanted to learn more about it and whether it was linked to who they were as a person.

The vast majority of students referred to being interested in learning more about the subject with some students relating that they enjoyed knowing more than their peers. Specific topics that they were interested in learning more about were mentioned. In Biology, many of the topics mentioned centred around human Biology including dissection, immune system as well as biodiversity. In Chemistry, the topics of interest centred around learning about how ideas had changed over time, while in Physics, learning about space was mentioned.

Overall students valued and were interested in learning about real-life applications and being able to relate to the subject content in Biology and Chemistry. However, there were concerns raised within Physics around the balance between the teaching of application and knowledge. One of these concerns was about not knowing whether the Physics course was a sufficient foundation for future studies. Another was that there was too much application and that 'if the theory would be applied to an example we had not come across I think a lot of people would struggle to see how it could be applied because we have only learnt one specific example.' This lack of relatability or application made it difficult for this student to engage with the subject content. As well as the concerns raised above, there was also dissatisfaction raised about the order of the topics taught, as those students were most interested in learning about were left to the second year of the course. Several students spoke of the Physics syllabus in their interviews, and several parents were mentioned as having discussed the choice of the syllabus with the school. It was interesting that both schools were studying the same exam board, yet the criticisms of the course only stemmed quite strongly from one school with no criticisms from any of the Physics students in the other. Perhaps this is linked to a difference in course delivery or wider access to resources.

In addition to students being interested in the content and applications with the course, some also noted an interest in the range of resources available including refurbished Science rooms which helped to increase interest in practical work. As well as this there was a three-week field trip to Indonesia run by one of the schools which had encouraged some students to take up Biology. Some students mentioned practical activities, and others valued the intrinsic reward that came from reflecting on these experiences and

gaining a deeper understanding. In addition to this, some students were interested in the type of skills they used and developed across the course in terms of practical skills, creativity and essay writing.

Different students focused on different facets to draw together whether they were interested in studying a subject further and this in turn fed into their reasoning when considering their subject choices and trajectories. For three students, this was their primary consideration. For all the others, it was just one of a myriad of other factors to consider.

### Aspirations

Although not all students had an awareness of what they wanted to study at university and some knew what they were aiming for in terms of occupations. Of the twenty-two students interviewed, twenty of them had some idea. Students within the sample expressed a broad range of career aspirations, these included medicine, engineering, psychology, Natural Sciences, Biology, Physics, Marine Biology, biological illustration, veterinary medicine, sociology, biomedicine and philosophy. One student felt that she had not been sufficiently exposed to a range of careers through her teachers. As there is a wide range of avenues for further study listed above, perhaps this is a reflection of some awareness of students as to the differing career options available to them. However, this is also a purposive sample, so this view may not be representative of a larger proportion of students within the sixth forms.

For the majority of students in this study, their future plans influenced their subject choices quite significantly. Given the specialised nature of some of the courses they aspired to study post 18, many had researched further study before making decisions for A-level subjects. For most students getting onto a university course was an integral part towards their career or field of choice. The vast majority of students had an awareness of entry requirements for university, most had looked this up themselves, some had asked others, but most had picked suitable A-levels that should enable them to follow their aspirations. For some of these, it was a simple equation of 'if you want to do medicine you have to do Chemistry' while for other students they were able to list the range of

possible subject combinations that fulfilled the entry criteria for their degree. There was a smaller subsection of students who gained knowledge of entry requirements for courses through other avenues such as engineering trips, educated guesses and listening to others talk about it.

University perceptions of some subjects as facilitating or not were also raised, during interviews. Some students avoided subjects where universities may have perceived a subject to have been ‘not as highly rated’. This perception did not negatively affect the uptake of the Sciences because the Sciences were on the list of facilitating subjects. However, it did affect some of the subject chosen alongside it. Another term used by universities to encourage students towards studying those subjects without actually making them a requirement for the courses was ‘favourable’ – where universities looked on a range of subjects favourably a student was more likely to choose of those. One benefit of having an awareness of university requirements was that it encouraged students to find out why these subjects were needed; this included why mathematics and Physics were useful for philosophy as well as why Chemistry was a requirement for a medicine course. This allowed students to look beyond course requirements and explore how they would be useful preparation for next steps.

In terms of trajectories, nine of the students in the sample followed a direct trajectory when choosing their options. These had chosen high visibility occupations in medicine, veterinary medicine, psychology, marine Biology, sociology, and engineering. These students had either decided on a career or at the very least the degree that they wanted to study at university and as such displayed the most stable subject commitment. Students development of their career choices over time varied between students and, in retrospect, could have been unpicked further. Some students had wanted to pursue careers from a young age, while other students looked at themselves as people with skills and personality traits and used that to decide what suited to them more.

Two students followed a multiple-projection trajectory where they continually changed their minds about subject choices or careers. Reasons shared for doing those focused on happiness and future financial stability. Over time one of the students changed her aspirations from media to Biomedical Sciences then to nursing. The other changed her mind between natural Sciences and geography.

Seven students followed a partially resolved trajectory where they had not necessarily chosen a career but were aware of the usefulness of their subjects for future study and careers. Several students shared how they used a combination of A-level subjects that would not limit their university choices and to allow them the freedom to pursue what they decide they want to study without needing to make an absolute decision at the start of their A-levels. For some students, it is not a case of keeping options completely open, but rather leaving particular doors open. An example of this was a student who appeared to be undecided and had two different plans ‘probably do psychology’ but ‘would need Mathematics, just in case I wanted to go into Chemistry’. Another student who is aspiring to study veterinary medicine stated that she also kept either biomedicine or bioChemistry at the back of her mind because she was aware that ‘there was quite a big chance that I probably would not get in.’ This was the only student that had mentioned a specific backup plan, in case she did not get into a competitive subject, despite five aspiring doctors being part of the sample.

One student in the sample used a funnelling identifier trajectory where he narrowed his choices over time, adapting his career aspirations and subjects for A-levels for better economic stability in the future. This student was considering either engineering or product design. Sharing the thought processes he was using to narrow down his future ambitions, he said he ‘also considered engineering because sometimes it could be hard to get into graphic design especially if you are self-employed and the work might not be as consistent.’ The student explained how he had chosen core A-levels that would allow him to study either and so avoid making a direct decision. Perhaps this focus on financial stability is a reflection of the challenging economic climate we are experiencing and the increased competition for stable employment.

Although not directly related to aspirations, the flexibility within university entry requirements meant that students had, in turn, some flexibility with regards to the combination of subjects they chose. Students expressed an awareness of getting the balance right for themselves as learners regarding workload, creativity, developing a wider range of skills, whether subjects reinforced each other and likelihood of employability. Perhaps taking into account, these additional factors was an attempt to improve their chances of success in these courses.

There were a minority of students who had not made any decision about careers or university. They relied exclusively on other factors to help them make their decisions.

## Ability

The vast majority of students interviewed referred to ability within their interviews; three of twenty-two students were the exception to this. These references to ability were done in a variety of contexts and to make several different points referring to attainment, self-efficacy and early entry success motivators.

There was a range of measures that students used to make judgements of their level of achievement. These ranged from mock exam results, projected attainment and final GCSE results. Some students used their MOCKS as an indication of projected attainment and used them to distinguish strengths from weaknesses. In many schools, the MOCK examination process is used to encourage students to begin early study for their final GCSEs and more commonly to help guide them as to where they need to focus their studies and improve performance. For all students, their GCSE results served as a gateway to A-levels. If they met the minimum entry requirements for the course, they had the option of choosing it, and if they had not made the entry requirements, then they were not in a position to pick. Some used their results to help them narrow down their final decisions. In cases where students had applied for courses they had not studied at GCSE, for example, psychology, students shared that they looked at their attainment in similar subjects to help them.

Some students suggest that their GCSE results helped them make their final A-level choices. However, for many of these students, the deadline for applications to the sixth form is in between the end of the autumn term and the beginning of the spring term, so they cannot be using this entirely in isolation. Perhaps where students are referring to their GCSE results explicitly, they may be using this to finalise and confirm their choices before enrolment on the courses at sixth form.

Arising from the interview data was the sense of effort or work that went towards achieving the results. Some had struggled with some of the content, despite their high

grades, while several students mentioned how easy they had found the GCSE Sciences. This perceived lack of effort at GCSE is worrying. One student exemplifies this in a description showing how it can deter students from choosing a subject at A-level. She says: 'I was good at it, but I barely tried for Mathematics GCSE, even though I got an A like. I think for A-level I have got friends who do it and no way!'. Perhaps if students get to the stage in a subject, where they plateau in terms of challenge and development yet can get a good grade with minimal effort, this may lead to a lack of resilience when faced with new content they may not be so familiar with. These students could be said to have qualified but perhaps without a sense of attainment.

The above point also links to another aspect of ability that arose was that of self-efficacy; the students' confidence in their ability to cope with STEM subjects, and whether or not they believe they are capable of attainment on the A-level course. Some students used the perceived level of difficulty as a tool to choose between subjects; others anticipated that different parts of the course would vary in difficulty and that this could manifest itself in terms of mathematical content, literacy as well as the heaviness of the content. Although some students avoided, and in one case regretted choosing subjects they thought would be too difficult, others did not always choose the option they perceived as easier, and the choices made were not always logical. For example, a student who was studying both mathematics and further mathematics at AS level explained that she had decided against studying Physics because she found the mathematical aspects of Physics difficult.

While many students chose subjects they felt they could do well in, they also shared explanations for why they avoided others. As this is one of the first steps towards university education and has quite a significant impact on what they study and where they study, there is an added pressure to ensure they get the highest of grades and so some students adopted an approach which minimised the risk of low grades. One student described a discussion during the open evening, where his teacher explained how this worked and the impact this discussion then had on subject choices:

*'you could get an A\* this year, but you might get a C next year.  
When we started A-level, they told us this thing about ALIS grades  
where they take the total GCSE grades of everyone who has done  
GCSEs and then done Science A-levels. They average them out, and*

*they take a value for what you got for GCSEs, and they use that to predict what you get using your GCSE results. A lot of people who got A's in GCSEs are not predicted C's and B's and I suppose that is not a very... If you have a love for English and you're guaranteed a good grade in it, but you got a good grade in Science, but you're only going to get a C you're more inclined to go for English, especially as you like it already.'*

A survey of 500 students conducted by Siemens in 2006 found that 70% of 6th-form pupils believed it was harder to get an A grade in Science subjects compared to other subjects. For two-thirds of those surveyed, the perceived level of difficulty was a key factor in deciding whether to choose these subjects (House of Commons, 2009). More than just a perception, evidence for this is also reflected in the chances of students attaining highly, using predicted ALPS grades as well as the ALIS calculations. According to the report by the Centre for Evaluation and Monitoring (Coe et al., 2008) 'STEM subjects are not just more difficult on average than the non-Sciences, they are actually without exception among the hardest of all A-levels' (ibid: 112). Despite the difference in difficulty, an A grade in two different subjects is worth the same quantitative value in terms of tariff points for university entry. With this being a relatively 'high risk' choice, some students choose to avoid higher risk subjects such as the Sciences in favour of more accessible subjects with higher predicted grades such as English.

The majority of the students also referred to their ability; this was whether they felt they were intrinsically good at a subject. They spoke of their perceived natural aptitude & skills, which set they were in, the pace they learnt at, general ability compared to peers or in other subjects. A few students drew on sources other than themselves to measure their aptitude. This included the Morris B aptitude test, and their teacher's perceptions.

A common feature in both schools which encouraged the take-up of maths subjects was the early entry of high-achieving mathematics students at GCSE. These students were then able to pursue an extended qualification which covered features of the A-level course. Six of the students interviewed were studying further Mathematics. Several students mentioned early entry of GCSE mathematics as a positive, motivating



experience which raised their confidence and allowed them to believe they could do well. In turn, this encouraged them to study A-level Mathematics and in some cases inspired them to study for a further Mathematics A-level qualification too as they felt they had a head start. This was specific to Mathematics and was not raised about any other subject. Perhaps having had a head start compared to their peers these students saw themselves belonging to what Matthews and Pepper (2005) describe as the ‘clever core’ of capable mathematicians, and through that seeing Mathematics as relevant and doable, and therefore enjoying its logic and problem-solving abilities. This was not the only way schools had encouraged subject choices. The rest are discussed below.

## School

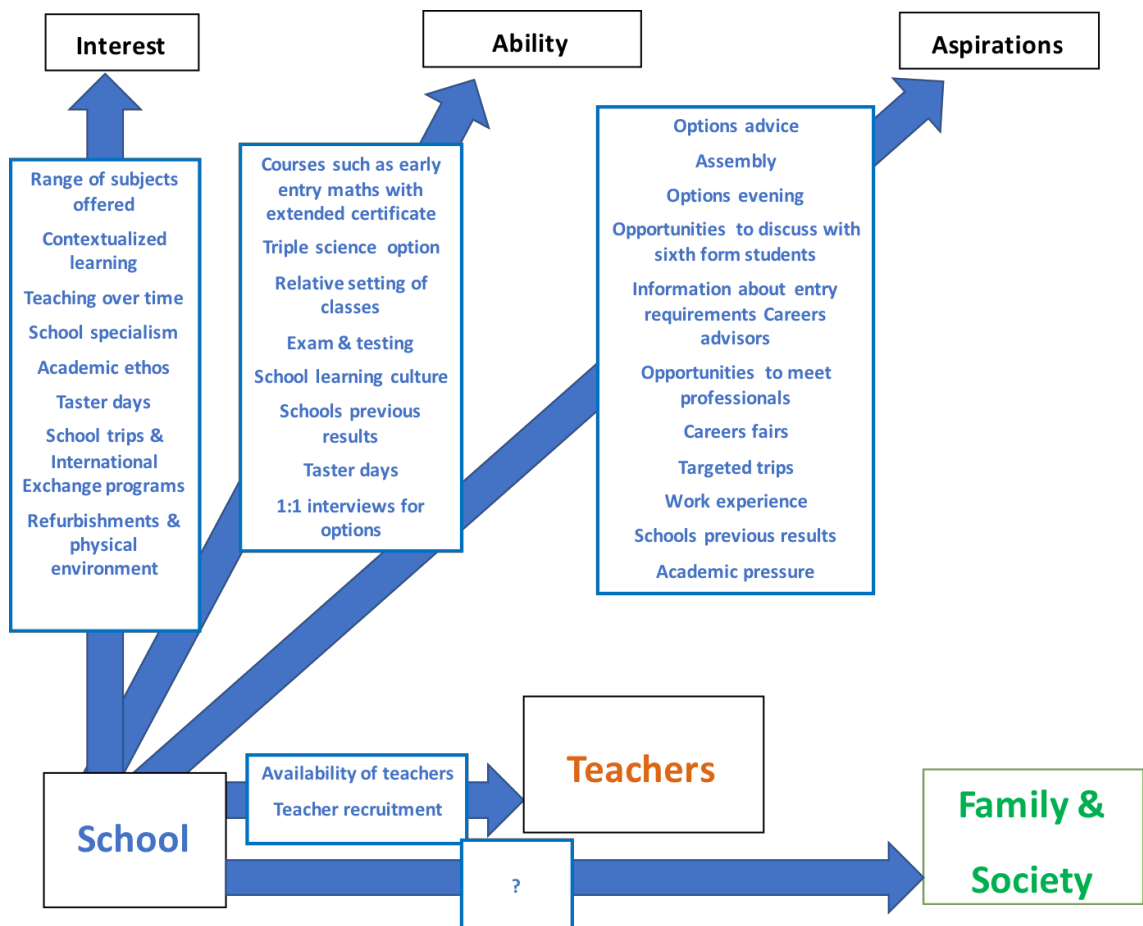


Figure 11 Links between the school and other factors

The school had a variety of ways in which it potentially affected student choices. These ranged from factors that had had a long-term effect on the students schooling experience,

as well a range of strategies and interventions in place to support students through the choice process and to plan next steps. Looking at the range discussed below it is clear that, the school effect was linked to measuring or informing a student's ability, helping to support through advice regarding subject or careers choices and stimulating interest in the subjects. These contributions are summarised in figure 11 and discussed in more detail in this section.

For the most part despite the majority of the students in the sample choosing a direct or partially resolved trajectory for a core of their subjects, there was often a flexibility in the combination of subjects a student could study. This is where the school continued to play a key part in terms of helping to finalise decisions. For students, the combination of their aspirations as well as their experiences and support during year 11 were useful in confirming their final combination of subjects, and so the support offered by the school informs their trajectories in several ways.

Firstly, the careers provision students are exposed to potentially allows students to choose and develop their career aspirations and so make informed choices about further study of subjects. Secondly, the way the subjects were taught and delivered over time had the potential to nurture a student's interest in the subject or field. Thirdly, the ethos of the school regarding learning and development can play a major role in encouraging students to embrace challenges and be resilient in the face of difficult concepts. These factors amongst others, including the interaction with experienced others that schools facilitate are discussed in this section.

One of the key long-term impacts of the school on subject choice was that of subject delivery rather than on the short-term events or assemblies focused on the decision-making process. One student reiterated 'It is not about special things; it is about maintaining the courses throughout the years.' This response echoes the ideas discussed in the interest section, earlier, and reinforces the long-term impact of teaching on students' attitudes towards the subjects and the knock-on effect that may have on their lifetime aspirations. There was also mention of the impact of the school's general environment and ethos. This ethos was described as stemming from the combination of staff, parents and students. For some students, this felt like academic pressure, and for others, this served as an encouragement to 'choose harder A-levels than I usually would

have done'. A school's perceived strengths or specialist status also had a role to play, with one student explaining he was not encouraged to study Science because 'this school is kind of like music and Mathematics orientated.' The school's academic results were also used as a factor by some students to indicate whether they would fit in and be supported through their course.

Both schools offered general advice about how students could approach the selection process. Students from both schools recounted that this guidance was shared through teachers and tutors within the schools, as well as through assemblies. Students referred to advice that encouraged picking subjects they were interested in and passionate about while thinking about what they want to be in the future. In addition to this schools offered taster days, open evenings, opportunities to talk to staff and students, as well as varying forms of career guidance provision.

It is clear that as well as helping to support students in making the right choices for themselves as individuals there was also a pivotal role played by staff regarding recruiting students to their particular sixth forms and subjects. The differing aims behind each of the events or strategies were not always clear to the students, and perhaps to teachers too. Sharing the purpose would help to manage expectations with regards to the sort of support they should reasonably expect in the lead-up to making their decision.

All students had attended a taster day while in year 11, and a few students had attended several. Taster days give students an opportunity to attend the sixth form for a day and experience A-level lessons in subjects of their choice. The general environment was described by some as casual possibly because of the relative lack of rules in comparison to secondary school and perhaps because in one school they did not need to wear their regular school uniform. Taster days offered the opportunity for students to attend sample lessons of the subjects they had selected. The sessions were also an opportunity for teachers to emphasise the kind of activities, as well as the level of challenge students, may experience during the course and to set expectations about the difficulty of the course. Students found that it was particularly useful for subjects they had not studied at GCSE. For many of the student's taster lessons were also about confirming their choices. Other students mentioned taking subjects they were unsure about to help finalise their decisions. Many of the students had expressed a strong subject commitment to at least

two of their subjects but were not entirely decided on final subjects, and so some used this strategy. Some students displayed disappointment with the nature of some of the content in the taster lessons. The sessions were perceived by students as an opportunity for teachers to encourage uptake to the subject through particularly fun or challenging activities rather than to give a realistic example of what studying the subject may have been like regarding the everyday experience.

Students in both schools had individual meetings with staff regarding their options. For some, this was a discussion where they considered students' strengths, grades, and what courses may be suitable for them, and for others, it was a quick confirmation of choices. Given the individualised nature of these interviews, it is very likely that each of the students had a unique experience, and perceived it differently. There were several expressions of dissatisfaction with the process, two of the examples are included. One student, who had followed the multiple-projection trajectory and was unsure of what to do in the future, explained that she felt that they 'never really sat down with someone and talked about what we wanted to do and what we were interested in. So I think it would have been better if they had done that and asked not just because you're good at something but if you really enjoyed it.' Another student, who had followed a partially resolved trajectory, was left feeling like she was not guided enough. She linked this to her doing well across a wide range of subjects, and so from her perspective, 'I do not think they could say anything different to the next teacher because they see your work in class and that is about it.' Perhaps these issues could be resolved by managing expectations through either clarifying the aims of the meeting itself, to explain whether it is about helping with the choice process in its earlier stages of considering options or it is to confirm whether a student could study the course.

Although not directly linked to A-level subject choices, students who have a clearer career in mind usually have a stronger commitment to their subject choices. Both schools had a careers advisor and offered students the option of approaching them. For a significant proportion of students interviewed the careers advisor was a disappointment. At the simplest level, it was because many students were never contacted by the advisor, despite stating that they expressed an interest in booking an appointment with them and putting their names on 'the list'. For some of those students who did manage to speak with a careers advisor, it was useful as they were able to discuss careers, sixth form choices as

well as subject combinations. For others, it was helpful as they gained access to resources and were able to consider various routes forward. One aspiring veterinary student was disappointed with her twenty-minute appointment as she felt the careers advisor was not familiar with the university application process for her course and recommended independent searching online. She explains that she was frustrated as she had already done that before the appointment and because 'it seems like the type of thing he probably should have known - especially like because it was veterinary – it is not like it was a random one.' This student had doubts about the career advisor's credibility and knowledge about her chosen career.

Both schools ran options evenings where subject teachers, and in some cases, current sixth form students too, had a stall that students could approach get any handouts from the department, and ask any questions about the structure of the course and the subject. Some students while perhaps engaged on the evening saw the event as part of the whole school experience they had already received, and at least some of the students were trying to gauge what day to day lessons would be like in the subject away from the marketing of the evening. The timing of when the evening took place, meant that several students felt it was not so useful with regards choosing their options, as such for them it was at most about helping them to confirm their choices, rather than to make their decisions. While there was an opportunity for students to consider their subjects, the options evenings are also aiming to recruit students to study at the sixth form rather than other institutions. The objectives of the evening were not made clear to all students with one student was able to describe the structure of the evening but referred to it as a career fair throughout. Another claimed 'it was useful' but suggested it should have had an element of helping students 'about thinking further ahead' to careers and universities.

Other strategies that students raised as being used within one of the schools involved a peer meeting with a student already in the sixth form. One of the students shared that speaking with older peers about the process was natural but expressed her frustration about the administration aspect of the process, she shared that students would 'talk about it naturally but when they make you fill in forms together and stuff it's more forced.'

None of the students were asked explicitly about work experience, but two students shared their experiences. Both students explained how this experience had helped them to gain some awareness of the diversity of Science careers available.

Another experience that was used to help support the choice of careers was a career fair. One school had organised two fairs for students. The first was a vocational career fair they had attended offsite with the school. The event was planned instead of offering work experience placements for students. For these students, it was clear that the types of careers on offer during the fair was not what they were aiming for and perhaps knowing that this had cost them a work experience placement made it more disappointing. The school had also organised an internal career fair with stalls and leaflets although it was still described as improvised by one student and odd by another because of the mismatch between those manning the stalls and the careers they were meant to be representing. One student explained that ‘the medicine table they had a dentist and someone who was a doctor in Biology but was not a doctor in medicine, so like if you want to study medicine there was no one who actually had been through the process’. While some students acknowledged that it is hard to organise a broad range of careers, others were not able to ask questions that they wanted to and felt time would have been better spent looking up information on the internet. Taking on board these comments, for these events to be useful to students they need to have professionals from the field of interest or those who have working knowledge of entry pathways into the field for students to meet.

Regarding extra-curricular enrichment, it was clear that there was a disparity in the range of activities students took part in. Opportunities available differed depending on whether students had studied double or triple Science, organised these themselves and what their gender was. External events included Science and engineering fairs, as well as external lectures. One school ran selective trips for different groups of people with several of these trips targeting girls to encourage them further into engineering and the physical Sciences. Some of these were more positive experiences than others. A female student had been recommended a trip, at the end of her GCSE course, with the aim of encouraging girls into engineering careers. In her own words, she found the experience ‘slightly patronising’. She explains the trip in the extract below:

*'We had to make container ships, using materials that they gave us, to carry bags of sands across a tub of water. I do not know I just thought it was quite basic and like the challenges that you do on focus days in year 9. And it was not worth it because they said it was going to be at a university and we went to Newcastle and stayed in the hall of residence. But it was not any sort of university-level Science. When I went, I knew I already wanted to study engineering regardless of the course but a lot of people had been told that because they liked Science, they might want to check out engineering and I did not think it was the best example of what engineering would actually be like. It was quite boring. I do not like how much they focused on it's great that you're here because you are all girls. I thought it would have been more interesting if we were exposed to Science we had not already learnt.'*

It is thought-provoking to hear this from a student's perspective because on the surface what seems to have been a good idea was not a good experience for this student. Her final comment also raises issues about the explicit focus on such events. This same student explained another opportunity on an international university exchange programme where PhD students presented their work to a mixed gender group of students and allowed them to access cutting-edge equipment and research.

While the role of the school overall has been shown above to be so multifaceted, none of the students attributed their choices entirely to the school, and this is in keeping with the framework where a range of factors was taken into account. While teachers were integral to the school, they had a distinct role to play for students, and so they have been kept as a separate theme, and their input is discussed below.

## Teachers

A significant part of a students' education in a subject is delivered and facilitated by their teachers, and so students referred to their teachers in a range of ways. Their role, as classroom practitioners, was raised, as well as their relationship with students and the

type of support they offered. As well as being linked to the school, teachers were linked to other themes; mainly interest in a subject, support and guidance and ability. These links are summarised in the figure 12.

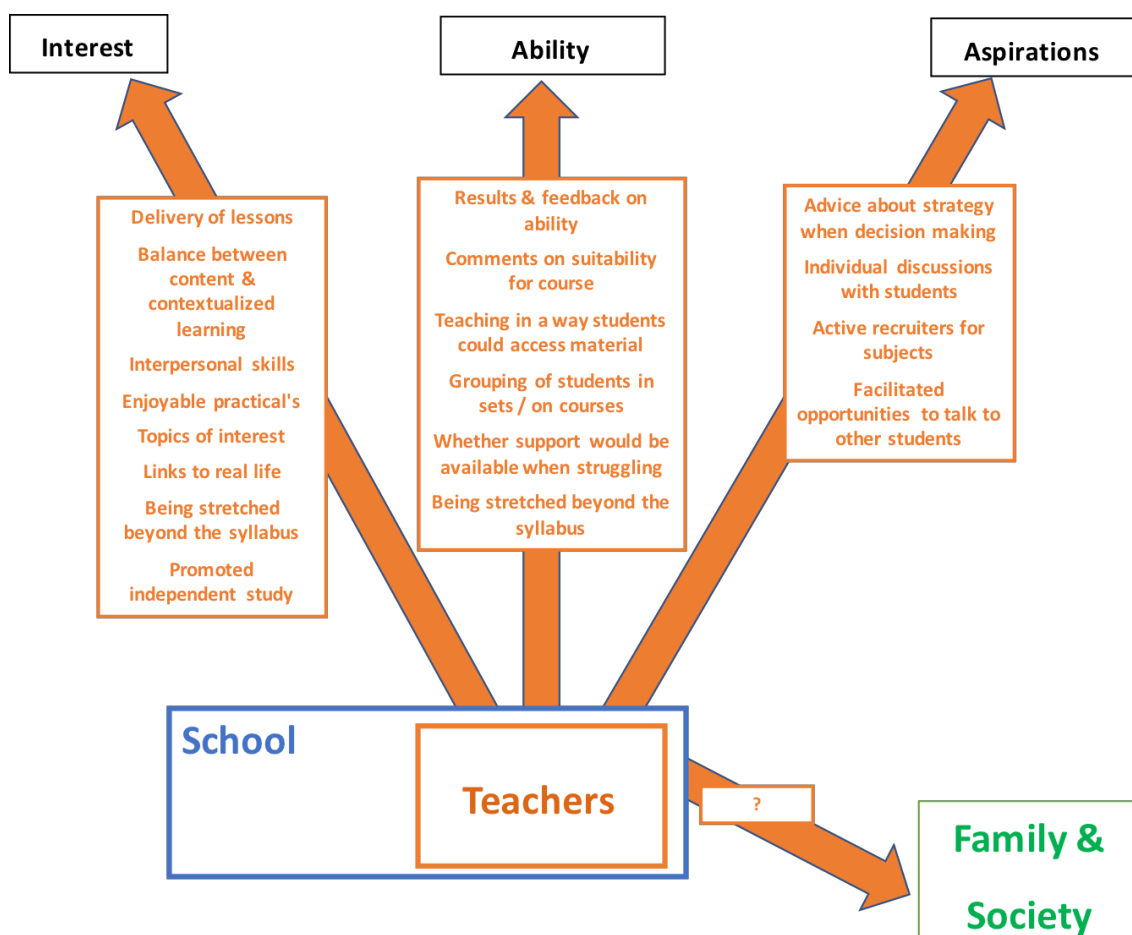


Figure 12 Links between teachers and other factors

The fundamental role of teachers is to teach their subjects, and as such many of the students referred to their teachers' delivery of the lessons. Some students chose to study a subject because they were inspired by teachers, many students recognised the long-term effects teachers had on students throughout their secondary schooling. Regarding actual day to day teaching methods, several students raised how the teachers' applications of theory to real life helped to interest students in lessons. An inspirational episode in a lesson on reacting amounts was recounted where a Chemistry teacher 'stood there with a hydrogen balloon and said 'we're making water'. We all got our umbrellas out thinking; I do not know what we were thinking, that we would get soaked and then bang and we were like 'where is the water?' and she was like 'we just made like the tiniest amount' and



she explained how.’ Some students appeared to compare the delivery of activities between Science lessons. They described some lessons as fun, and one made a distinction briefly describing the different ways practicals were delivered. She says: ‘we did better practical’s in Chemistry and Biology because they made more fun of it than Physics, which was just do it and then pack away.’ It is worth considering how the delivery of apparently similar teaching activities could have such a wide range of impact on the students.

Other students chose subjects despite negative classroom experiences; one student shared how she learnt independently through the textbook in lessons throughout her GCSE course and enjoyed the subject because what she read was interesting to her. Others suggested that lessons had minimal practical’s and was taught repetitively, and in turn, they were put off reading about the subject outside of lessons. A similar issue was raised in research conducted by Nardi and Steward (2003), and Mathews and Pepper (2005) who found substantial evidence suggesting that experiences where students felt isolated, and where they were immersed in repetition-based learning could have a negative impact on attitudes to the subject. Although their research was focused on learning within Mathematics education, perhaps it has parallels within subjects such as Biology too.

However, there was evidence from other students that teachers’ delivery of a subject could make a traditionally ‘hard subject’ more accessible, thereby altering the perceived difficulty of the subject itself. One student shared: ‘She would teach you Mathematics as though like ‘you guys already know this, I’m just going to go over it just to remind you guys’. It is the first time I have seen it though; do you know what I mean? So, she made you view it as easy’. This entry point for teaching the material empowered this student to approach the subject matter and made it more accessible for her.

There is a concern that some students choose subjects based on teachers rather than an interest in the subject itself, however, although teachers were considered by some students, they rarely dominated the decision of those interviewed. Many of the students referred to their teachers as recruiters for their subjects, trying to get students to join the A-level course. However, this was usually done during open evening and at sixth form recruitment, at a time when quite a lot of the students had already made their decisions.

One student explains that he ‘felt bad for all those teachers who were trying to persuade me to do all their things because I had already decided’.

Three students mentioned concerns about the issue of teacher recruitment and teachers leaving. Both comments by students perhaps reaffirmed the importance of a teacher in introducing and engaging students with the subject matter itself, but also the uncertainty for students at A-level when they are not sure whether they will have a good, approachable specialist teacher for the course. Two students made an effort to try to work out who would be teaching them as this would affect whether they opted for the subject or not. This technique was used as an indication of what the teaching quality would be like, as well as the support that may be in place.

The support mentioned and valued by students was not just regarding approachability when the subject content had become more difficult, but it was also spoken about in the sense of the opportunities they had been exposed to when being stretched beyond the GCSE syllabus. A student described how his Physics teacher:

*‘would teach us some A-level things that you do not need to know it but it is good to know the knowledge anyway and it kind of intrigued me because as I was doing the GCSE, he taught us Physics. He taught us things that I did not really understand but things that I wanted to understand it. So, that kind of made me want to take A-level Mathematics and Sciences because I kept on thinking I keep being told I’m being taught simple things and I did not really want to know the simple things I want to know a bit more advanced things.’*

When describing their schooling experience several students valued being exposed to the subject matter in depth, being given extra work beyond the syllabus and having the freedom to study independently meant they enjoyed the teaching within the subject. Several students echoed this view across a range of subjects, including philosophy and sociology.

Another role of the teacher appeared to be a source of information about the nature of the course, as well as expectations regarding attainment and managing workload. Conversations with teachers were integral to the decision process with many of those interviewed being selective in choosing which teachers they discussed their choices with.

Some students based this on teachers who they got along well with while others focused on subject-specific advice from teachers of the subjects they were interested in pursuing. Both schools structured opportunities for teachers to discuss choices with students, but one student suggests this was limited in its effectiveness, in comparison to those interactions that were initiated informally by students.

In light of the trajectories framework, it is clear that a teacher has a role to play regarding helping to develop attitudes to the subject they teach, developing a student's competency in the subject as well as modelling an approach to learning.

### **Family & wider society**

Several of the students mentioned having spoken to or taken advice from a variety of people around them. A small minority chose not to and preferred not to have too many outside influences, to keep it as an individual decision. A summary of the links between family and wider society and other factors are included in the figure 13.

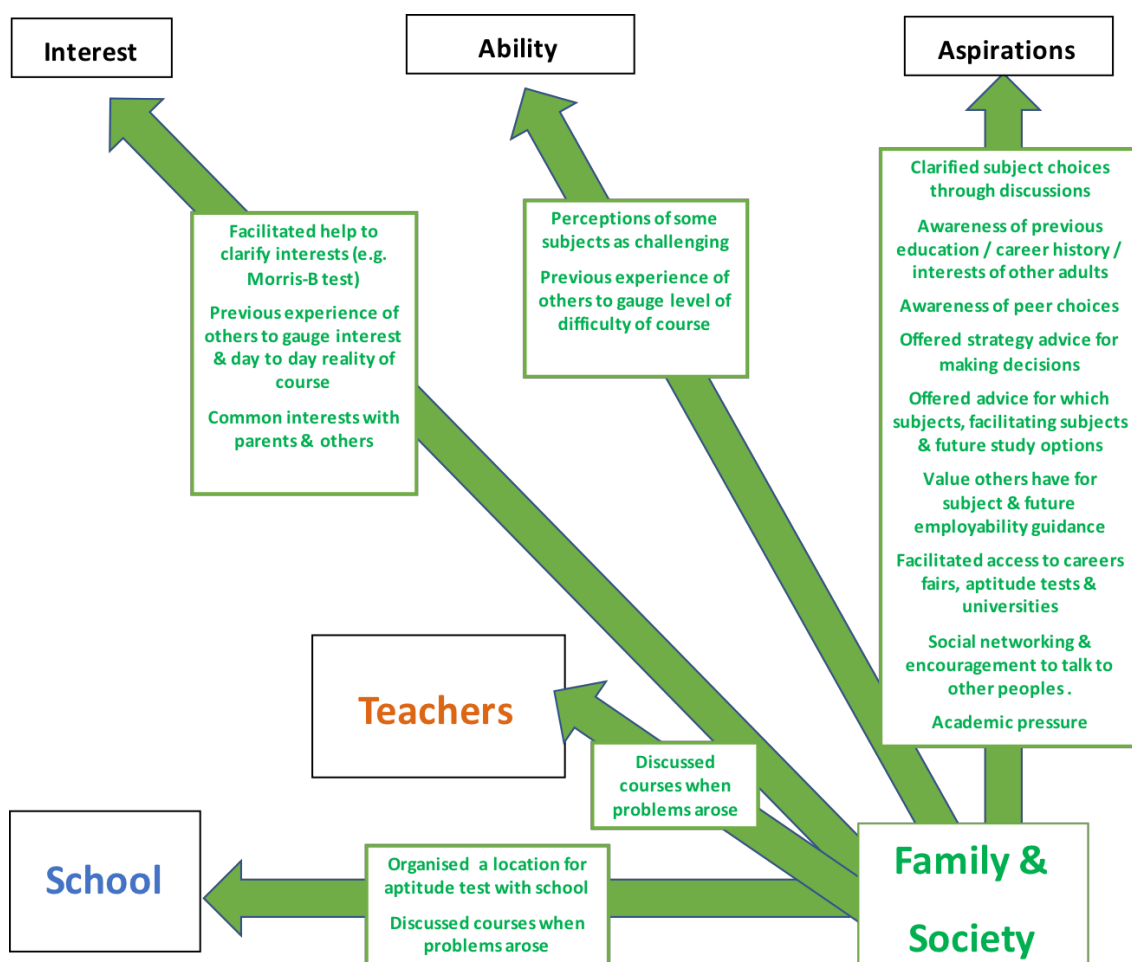


Figure 13 Links between family & society and other factors

The majority of students discussed their choices with family members. There was a diverse range of responses suggesting how these interactions were useful. Some students looked at their family for advice on approaches to narrowing down the subjects, others looked at the educational/career experiences of their family members and learnt from that, while others received guidance towards particular career choices or specific subject preferences.

Numerous students mentioned using the experience of their families, with students more likely to choose subjects that a family member had chosen and enjoyed, perhaps seeing it as part of their identity. One student who opted to study psychology explained that as well as having studied it at GCSE ‘my sister is taking it for uni and my mum has got a degree in it, so I think it is in the blood!’ Another student who was encouraged by the experience of a family member ‘have lots of family who have taken different subjects for

uni as well, for example, philosophy, psychology and Chemistry. So, that is the reason, why I took them.’ He took all three of those subjects. Another student who discussed the options with her parents shares that she ‘knew I was going to do art or product design and Physics and Mathematics. But I also considered drama - I always have in the past my mum works in the theatre business.’ For many of these students perhaps knowing that someone they knew had already chosen this and had had a positive experience, whether that means enjoying it or having a career through it made it more accessible to them as an option.

There were also examples of students who avoided subjects given their family members’ negative experiences. These experiences included the sharing of the day to day negative experiences of having studied the courses they were considering, as well as a more in-depth insight into what the subject content and skills.

Some students shared their awareness of which subjects their parents valued more, and although did not exclusively follow this had taken it into account. Some students had expressed an interest in pursuing subjects their families were not familiar with, and in some cases, parents were instrumental in encouraging them to talk to others who had studied those subjects for support and advice. Some students reached out to family members to discuss careers advice and choices with. One boy, who wanted to study Physics, described long-term support and the transferred passion he had for the subject that he shared with his father saying ‘he wished he did Physics at university, but he did Mathematics. So, he has always been interested in it as well.’ Another who spoke to his mum about the decision-making process explains, ‘speaking to someone else about it helps you think about what you want to do if there is someone else asking you questions about it.’ For this student, as well as others, being able to clarify thoughts as well as weigh up advantages and disadvantages through speaking was useful.

The emphasis on focusing on careers and university was recurrent among several students. In some cases, some parents encouraged students towards particular subjects to support them towards better employability, while some made choices for their children based on perceived usefulness when applying for university. Some parents chose to direct their children to go to specific universities so that they could work backwards to choose subjects. One student described his parents informing him about facilitating subjects who

‘both work in universities, so they were saying they got me a list of these subjects, and they were like these are hard subjects and these are soft subjects. You have got to do a certain amount of these ones’.

As well as students using previous experiences of family members, some also did the same with their peers or older students who had already gone through the process. Some of these discussions involved probing questions that allowed the student to consider their suitability for the course, while others allowed them to gain insight into the day to day experience of the course itself and the teaching of it. For other students having friends who were interested in similar subjects and who chose to pursue it, as well as having the opportunity to discuss Science together may have added to the interest in Science. Most of the students despite speaking to their friends claimed they were not affected by them. For some students, their usefulness was limited because they were interested in different things, and for others just listening to what other people chose was useful, without the need for discussion. One student had taken a gap year, and so watched his friends make their choices the preceding years. When asked whether they had affected him in any way he responded ‘not particularly, some people can get dragged into the thing if you’re going to be doing this, people want to be together, but there was enough of my friends who were doing my courses I was not really worrying about that.’ The tone of the response suggests a student who knew what he wanted to do, but also signals to me that perhaps admitting to getting any help from friends would suggest a student was not individual enough, or that they went with the crowd.

## **Main Findings of Interviews**

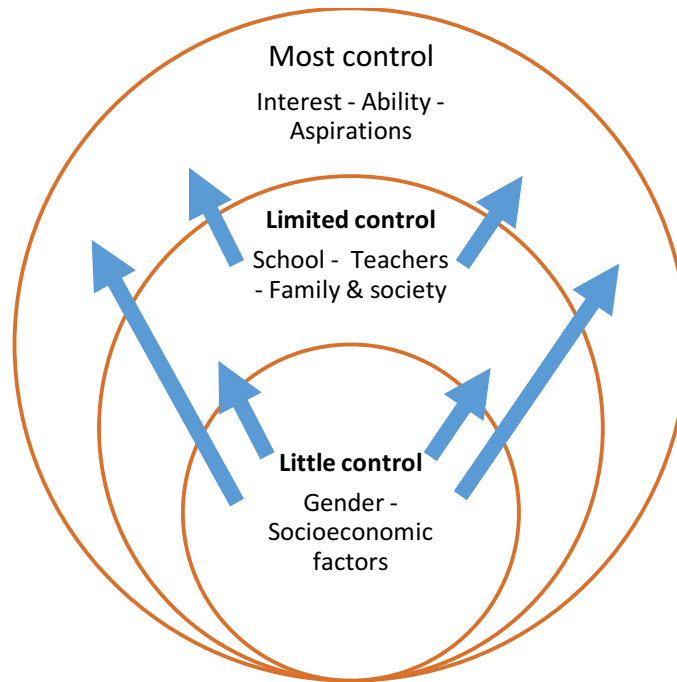
Initially, interviews gave information about overall trajectories followed. Most students used direct or partially resolved trajectories where they made their A-level choices based on their future careers and or areas of potential further study, displaying a stronger subject commitment to those subjects required for their future. For the subjects that were not necessary for their future study or careers, they used aspects of other trajectories. A minority of students had not yet considered a career or decided on an area of study and followed their interests and skills for all their subjects. One student developed his choices over time and reached a career and subject decision based on that. The remaining two

students followed a multiple-trajectory approach where they had changed their minds about their careers.

Underlying the individual trajectories was a range of factors that students raised in the interviews and these had a role to play in their subject selection. These were in line with the themes: interest, aspirations, ability, school, teachers and family & wider society.

An examination of the individual factors and their effects on student decisions show that there are links between the different factors for students. The factors themselves were separated into three main groups within the theoretical framework. The first of these groups are those factors that the student has the most control over, and these are; their interest in the subject, their aspirations and their ability (perceived & actual). If all three of these are in congruence and encouraging a student towards Science, the student is almost certainly going to choose to study Science(s) for A-level. However not all need to be present for students to choose to study a Science A-level. For example, some students have chosen to study Sciences such as Chemistry regardless of personal interest because they are aware of the instrumental use of it to fulfil their aspirations.

Underpinning the three factors, mentioned above, are the other factors identified within the literature review and the analysis of the interview data. An individual student has limited control over these remaining factors. These factors are: school-related factors, teachers and parents – embedded within those three groups are background items that students have little control over and these are socioeconomic factors and gender. Figure 14 shows this graphically. Having analysed the interview data, it is clear that factors within the limited control section are usually influential in encouraging uptake of the Sciences if they affect those with the factors within the ‘most control’ group – namely either interest, ability or aspirations.



*Figure 14 Representation of interaction between factors*

One example of how these factors are interlinked was with Amy, who was unsure of what to study. Her contacts within wider society made her aware of an aptitude test. Her family supported her through financial means, and as a result, the test gave her guidance which helped her build her future aspirations. Here ‘family & society’ linked to her building her aspirations. Another example is that of teachers at school who were often used by students to gauge their ability in certain subjects or for guidance with career goals. Schools through their entry requirements affect a student’s perceptions of their ability as well as facilitate careers advice. In light of the model above, the three main factors listed as affecting uptake are identified as ability, aspirations and interest. If educators and professionals want to affect change in option choices of students, then the interventions and support need to be focused on targeting those three factors. Each of these three factors is heavily interlinked with those within their ‘limited control’.

The ability factor within this study encompasses not just the attainment of a student but also their perceptions of their ability and their perceptions of their likelihood of success, as explained in the analysis section.

Students were more likely to choose a subject they felt they were likely to succeed in when studying, although they did not all measure ability in the same way. They measured



success using measures in place by the school, as well as by comparing themselves to other students and advice from teachers. One particular successful school-related factor that helped develop student's perceptions of their mathematical ability was their early entry in maths. This provided students with the confidence, and appeared to encourage them to continue maths as well as in some cases also further maths at A-level.

Students awareness of careers and their aspirations for the future were also complexly linked with the 'limited control' factors. Many had researched this and had used this to inform their A-level choices. They had taken advice from teachers, family, experiences of other students and external organisations to try to work out their next steps. This information resulted in some students choosing a range of A-levels to manage their workload, develop a range of skills, make them look like well-rounded able learners and improve their chances of employability. Other students considered University perceptions of subjects; this included using the advice regarding preferring facilitating subjects, as well as subjects that specified as being looked upon favourably in addition to the entry criteria for student's specific courses. Schools also offered advice about approaching choices, and facilitated support through targeted events such as taster days, option evenings and meetings with students, careers advisors and teachers. Each of these events varied in quality and depth and were received differently by different students. It would be useful if schools clarified the programme of support available to students in the lead-up to their options and the intended aims of each event, as this would help to manage expectations.

Students often referred to their interest relative to other subjects, as well as how long they had been interested in a subject. For some students, the subject matched to their identity or personality, and they had engaged with the subjects beyond the classroom. Their interest linked to a range of factors including their teaching experience, the ethos of the school, the opportunities available to both within and outside the school. Some of these enrichment activities planned by the school and wider society targeted those factors students had no control over and aimed to encourage particular genders or students from particular socioeconomic backgrounds into the Sciences. Although many of the students had shown strong subject commitment to at least two of their subjects, they had not entirely decided on final subjects. For some students, a strategy involving interest was

useful; they attended taster lessons for subjects they were unsure about as well as discussed these with selected others and used that to choose between the subjects.

A pattern emerges when analysing the trajectories and the revised grouping of the factors. Students who show congruence between the factors that they have more control over, tend towards particular trajectories. A summary of this is in the figure 15. For example, a student who believes they are able, has aspirations within the Sciences and is interested in Science often has a strong subject commitment and follows the direct trajectory towards a high visibility career. In contrast, a student who bases their options on ability alone may follow a multiple-projection or a precipitating trajectory where their interest may change, and so their choices or their perceived ability may change, or they may learn about a new career and so rethink their options. A student who has congruence between any two factors is likely to follow a partially resolved or funnelling identifier trajectory.

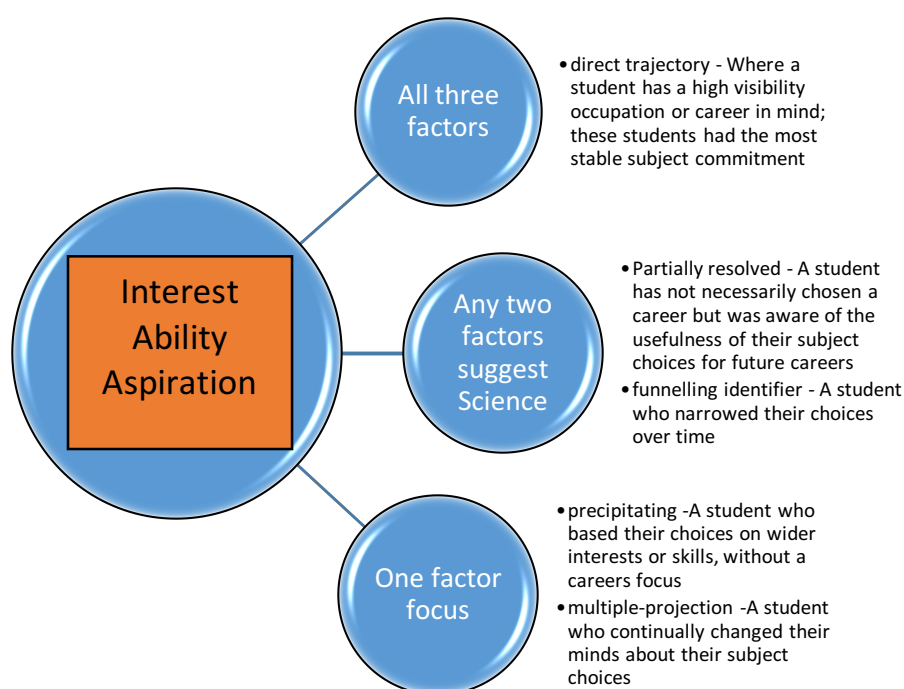


Figure 15 Model linking between trajectories followed and main factors used

Timothy, Twi and Ella mentioned earlier in the chapter and identified as having followed a direct trajectory, show a congruence between interest, ability and aspiration; this is also true for eight of the nine students who followed a direct trajectory. The ninth student made no mention of ability – although he was of the highest attaining in the cohort so it

may not have been a limiting factor in his consideration. Although there was overall congruence between all three factors for the eight students, that wasn't the case for each individual subject. For example, one student took Biology despite not liking it because she felt it was needed for medicine.

On the other hand, an example of a student who focused on mainly one factor was Nathan who studied Maths, Chemistry, Biology and Geography and he used a precipitating trajectory. In terms of his aspirations, he had not decided on a future course of study or a career. He chose Chemistry and maths as he enjoyed the challenge of the subjects. He liked finishing questions in maths and enjoyed Chemistry as it got harder. Biology was chosen as he was interested in learning more about it. He chose geography because he needed another subject and he thought he was able in it. He predominately focussed on his ability although he linked this to his enjoyment of the subjects.

Lucas based his choices on the combination of his interest and ability to decide on a career and from that subject choices, and he used a funnelling identifier trajectory. He was interested and skilled at GCSE art but wanted more structure so opted for product design instead. He added Spanish in as a choice because he was good at it and had got an A\* at GCSE, but would drop it at AS. In terms of career Lucas was interested into going into design, but felt there would be more stability in engineering. As he was considering engineering as a career and because he was good at Physics and maths, he chose these. He is aware that his subject combination could enable him to pursue either. He has a sense of direction regarding his career but his driving force towards his choices were his interests and ability that led to the career decision. Lucas doesn't quite fit the description of a direct trajectory because he has not yet chosen a career and although he does fit the partially resolved trajectory because he has narrowed his choices over time and does have a direction for career he fits the funnelling identifier description better. He does however, raise questions about the simplistic nature of figure 15. Having reached his decision there is now congruence between interest, ability and aspirations. The distinction being made here is that the overall driving forces were the interest and ability leading him towards the career rather than the career leading him towards his subject choices or a combination of all three from the outset.

While figure 15 shows some indication of how the variables within students control link together to preferred trajectories, it is not just about the number of variables considered but rather about the congruence between the three main variables. For example, Shaniqua looked at ability, interest and aspiration but there was little congruence between the three values, she was following a multiple-projection trajectory. She changed her mind as she changed her focus between aspiration, interest and ability. Shaniqua considered studying media, studying BTEC Health and Social care to get into nursing and A-levels to get into a degree for biomedical Sciences. Her interest led her towards media. Her career aspirations led her towards A levels so she could pursue a degree in biomedical Sciences and her ability led her towards a BTEC in Health and Social care. As such she changed her mind several times and she took considered and took into account all three main factors. She also looked into careers, talked to a careers advisor, looked at university entry requirements and spoke to people around her. As there was no congruence between her interest, ability and aspirations she changed her mind several times and followed a multiple projection trajectory. As she changed the factor she was focussing on, her choices changed.

This analysis has looked at identifying the subtlety between how the factors affect a student's uptake of subjects. It has grouped them according to the amount of control a student had over them and looked at how these factors interlink and feed into the three factors that students have more control over, and so better inform their decision-making. It ends by suggesting that increased congruence between the three student-based factors can lend itself towards particular trajectories – thereby increasing the subject commitment of students and possibly helping to promote the uptake of STEM subjects.

## Discussion & conclusion

The main aim of this study was to explore a range of narratives from high-achieving students who chose to continue studying Science during the post-compulsory phase. I was interested in finding out why and how students decide to choose Sciences at A-level and looking at the different factors and decision-making processes that affected their decisions on a personal level, including their experience of school Science. In this chapter, I have focused on what this study has shown in light of the research questions, and related research. I then highlight the original contributions of this project, identify the limitations of the research and offer implications of the findings along with possible areas for future study.

### Research question 1 – Which factors influence students A-level subject choices and how are they linked?

The ‘London Effect’ shows that schools in inner London have closed the KS4 attainment gap between disadvantaged and non-disadvantaged students and that unlike the rest of the country this has led to higher post 16 participation. In addition to this, the literature review showed evidence that both gender and socio-economic status impacts the choices students make. Looking at how the factors link to each other and support students can help to shed light on how students within inner London may have benefitted. These findings share some of the opportunities students are exposed to that help to support them, and so provide a mechanism to highlight where the gap in terms of improving the support in place for students could be closed. The implications of these findings and what can be done to further support students in their choices are also discussed.

Analysis of the survey data and looking at emerging themes within the interviews found that eight factors influenced student’s subject choices. These were organised into three layers. The first layer which students had little control over contained the two factors gender and socioeconomic status factors. The second layer which students has some limited control over were school, teachers and family & society. The final layer which students had the most control over contained interest, ability and aspirations. This section looks at how the factors can contribute to a student’s academic choices from a student’s

perspective. Factors that students had limited control were found to influence choices by feeding directly into either of the themes focused on their interest, ability, and aspirations.

## Interest

The results of the survey and interviews revealed that, in general, interest in and attitudes to Science were positive. This is in contrast to findings from the international ROSE study (Sjøberg & Schreiner, 2010), and the UK based study by Mansell (2011) who found that students were less interested in Science than most other subjects, and did not feel that Science and technology played a significant role in everyday life. This difference was expected, as this study sampled students that had chosen to study Science, so these results are not directly comparable to the wider range of students sampled in the other studies. However, the results are in agreement with findings from the more recently carried out Wellcome Trust Monitor surveys which found that 80% of young people (aged 14-18) found Science lessons interesting where over half of the students reported that they were more interesting than mathematics or English lessons (Clemence et al., 2013).

The 'Wellcome Trust Monitor: Wave 3' (Mori, 2016) found that when asked why they had pursued a job in the scientific or medical field 61% of respondents stated it was because they enjoyed or were interested in the area. There were 6% who said this was because of parental encouragement and 6% said it was because they had a good teacher (Mori, 2016). Looking at the figure 16 illustrates that an awareness of how factors link to each other to develop a person's interest is more important than who is most responsible for choices. The findings from the interviews show that feeding into a student's interest are the three limited control factors; school, teachers and family and society.

Students identified topics they wanted to explore further. These topics contained content with real-life applications, and that would allow their perception of the world to change through bringing about a deeper reflection of the Science of everyday occurrences. Some students enjoyed useful practical work within Science; others mentioned exposure to content that challenged their expectations and forced them to think about the Science of everyday phenomena. These findings are in keeping with a study by Lubben, Campbell and Dlamini (1996) who suggested that lower secondary students enjoyed contexts that

they felt were personally useful to them as well as information that they could use to help form views about controversial topics and that they could use to engage in debates or discussions. This may explain why some students had opted not to study physical Sciences. However, some concerns raised about the balance between application and knowledge in the AS level Physics course; some felt the subject was not related to what they would need for further studies. Their concerns are supported by parallel evidence found in studies relating to mathematics where students felt that contextualised learning activities were irrelevant (Kounine, Marks, & Truss, 2008; Nardi & Steward, 2003). This would suggest that there needs to be a balance between making lessons relevant to students while not limiting the content taught to specific contextual applications.

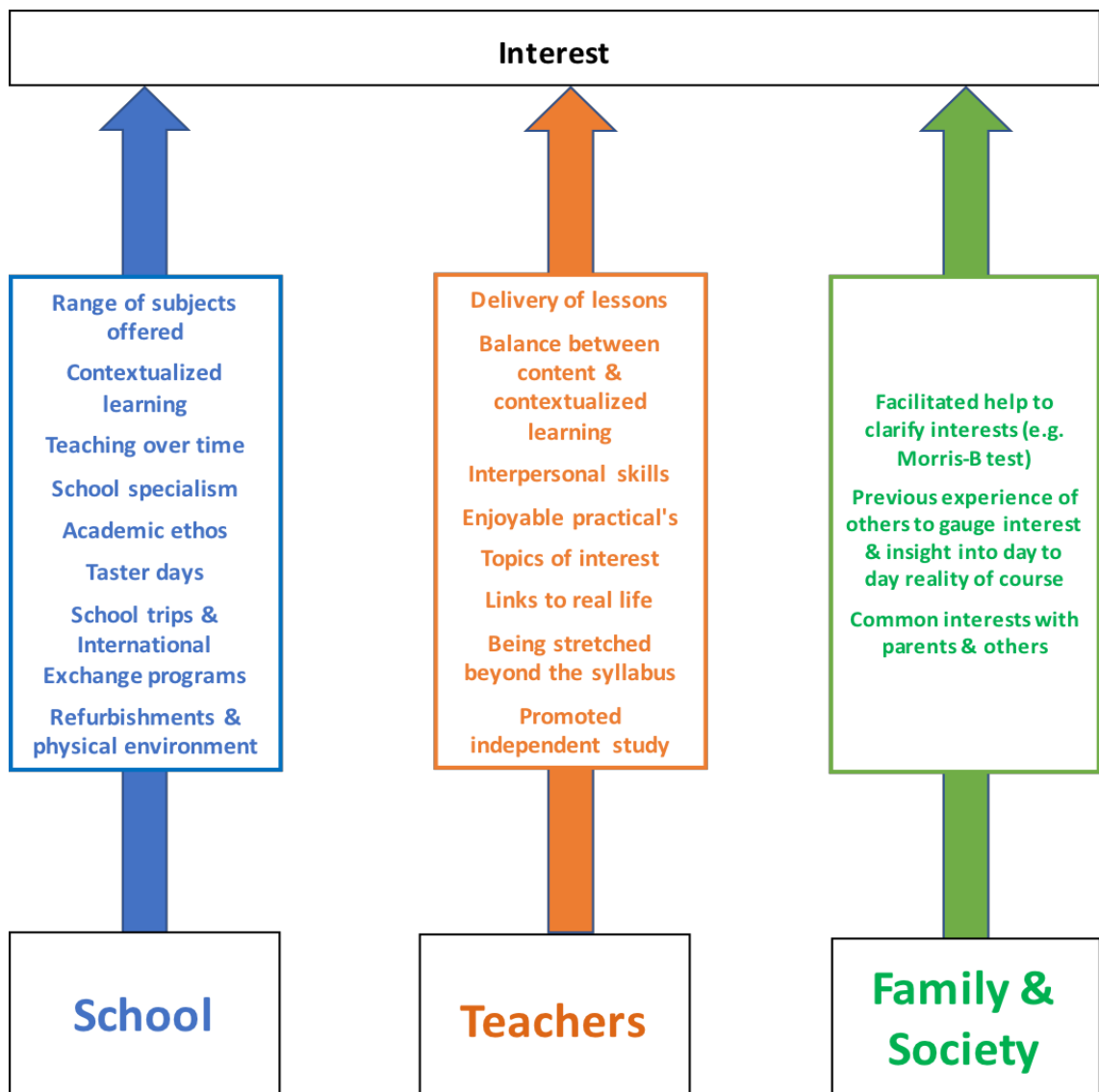


Figure 16 Factors that help to develop a student's interest in a subject.

Some students chose to study a subject because they experienced inspiring teaching. Several students mentioned the learning environment and a range of aspects that they valued in the classroom. Aspects students valued included teachers making learning enjoyable for the particular student, linking of theory to real life, engaging practical work and making challenging content accessible through good explanations. This is in line with findings from Lyons (2006a) and Hampden-Thompson and Bennett (2013) who also found that attitudes to Science improve when the curriculum is relevant, interactive, included discussions, hands-on experiments and when efforts were made to make the Science less difficult. Although some students valued being able to learn independently and grow more engaged with the subject content, others shared negative experiences of book-based learning in lessons and repetitive teaching as putting them off. A study by Springate, Harland, Lord & Wilkin (2008) found that poor teaching of physics and chemistry discouraged ethnic minority students from studying science further.

A report by Kirby and Cullinane (2017) states that Science teachers in London are more likely to possess a qualification in the subject that they teach than teachers in many other parts of the country. Evidence from established research shows that the most effective teachers have in-depth subject knowledge (Coe, Aloisi, Higgins & Major, 2014; Hattie, 2003; Osborne et al., 2003; Osborne et al., 2009). Several students spoke positively of experiences where they were taught beyond the curriculum at GCSE. Perhaps this approach of teaching beyond GCSE helps to whet the appetite of high-achieving students and allows them to engage with Science as a discipline. Engaging high-achieving students by challenging them beyond the curriculum and allowing them to engage with learning just for learning's sake may serve to encourage a love for the subject and allow a deeper learning bond to start forming. This alongside encouraging students to learn about a topic independently, or having a shared interest with another adult are aspects that students appreciated. This is also something that is currently encouraged through the recently launched Science capital teaching approach (Archer et al., 2015). Part of the approach is to promote and facilitate structured opportunities for students to talk about Science with adults at home with the aim of nurturing a common interest in Science. Both schools have shown some evidence into encouraging this amongst those disadvantaged by gender or lower socio-economic status by targeting some of their trips or enrichment activities for girls and for those who have been classified as disadvantaged.



Taster sessions were found to be useful when the lessons delivered satisfied the aims of the day by being interesting enough to encourage further study of the subject while importantly meeting the needs of the students by giving them a realistic idea of the course content and level of challenge they may face. Students also gained insight into what courses would be like by speaking to members of their family or others who had pursued those courses. This would mean that students who did not have people around them with that experience were at a disadvantage. Both schools offered opportunities to encourage students to speak to peers within the sixth form, and so perhaps being part of a school with a sixth form promotes interest in further study for students.

Of the factors that may have helped to support students develop their interest in a subject was the range of subjects offered. One example of this is taking GCSE maths early and doing an extended certificate; another is whether students are studying for the triple or double Science award. Perhaps worryingly researchers (Jin et al., 2011; Archer et al., 2016) have recently found that it is often not the students who make course decisions but schools and teachers and as such the nature of the opportunities on offer which promote interest may also reinforce disadvantage. From a social justice perspective, it is crucial that this is monitored on a school level by educators as part of their commitment to every child.

Students shared that trips were useful in promoting their interests. However, these trips were not always offered to everyone. As mentioned earlier some trips were targeted, whereas other opportunities depended on the student's course of study (double or triple), and who had organised the activity. As the courses students studied often linked to the range of enrichment activities offered, if students were not on triple Science courses they may have had limited opportunities to go on trips. Perhaps given that larger scale research projects have found that access to courses such as triple Science tends to favour the more advantaged (Jin et al., 2011; Archer et al., 2016) it may be useful to widen these opportunities available to focus on the disadvantaged on other courses too.

School A had an international exchange programme with a university abroad with some students getting the opportunity to view research projects and be exposed to sophisticated equipment, as well as an international field trip abroad as part of the Biology course. Students did not mention how these were funded and it was not clear whether students

with limited family income were prohibited from taking part in these trips. School B did not have any international trips, and the students did not mention these. There is evidence that students with limited means may not have the same breadth of learning because of limited opportunities to enhance a student's cultural capital (Reay, 2004). Overall students mentioned their interest in these enrichment activities. Perhaps increasing these and ensuring they are affordably available for students in a range of schools could help to develop students interest in the Sciences.

Opportunities focussing on promoting STEM for girls were potentially useful in promoting a student's interest in a subject (as well as career) and is a possible way to address the gendered disparity in subject uptake. Both schools had trips organised to encourage girls into greater engagement and uptake of the STEM subjects. Some girls expressed their frustration of trips that emphasised the targeting of girls, and offered lack of challenge, rather than expose them to more in-depth Science. While as educators we set up these opportunities to encourage girls into Science, perhaps we should avoid sharing that as the explicit message given to them during these events. It may be more efficient to focus our energies on engaging them with the subject content. While some studies have found that enrichment activities can have positive effects on engagement and participation (Bennett et al. 2013; Gorard, 2012; Hutchinson & Bentley, 2011) the PISA study in 2006 did not (OECD, 2007). The apparent contradiction can perhaps be explained using the issue of the quality of these experiences as raised by some students during the interviews.

### Ability

When the 'Wellcome Trust Monitor: Wave 3' (Mori, 2016) asked a random sample of professionals 'Why did you pursue a job in a scientific or medical field?' 14% of respondents responded because they were good at Science. Of those who had responded 26% were male, and 5% were women. In PISA, the largest gender difference reported in students' self-concept regarding Science, in the vast majority of OECD countries, showed that males thought significantly more highly of their Science abilities than females (OECD, 2007). In this study, a gendered difference in subject confidence was found between genders for Physics (but not Chemistry or Biology) with two out of three males

agreeing or strongly agreeing with the statement ‘I am good at Physics’ compared to one in three females, there wasn’t a gendered difference for Biology or Chemistry. Together would suggest that further work may need to be done to develop female student’s confidence in Physics to bridge this gap, even amongst students who choose to study Science.

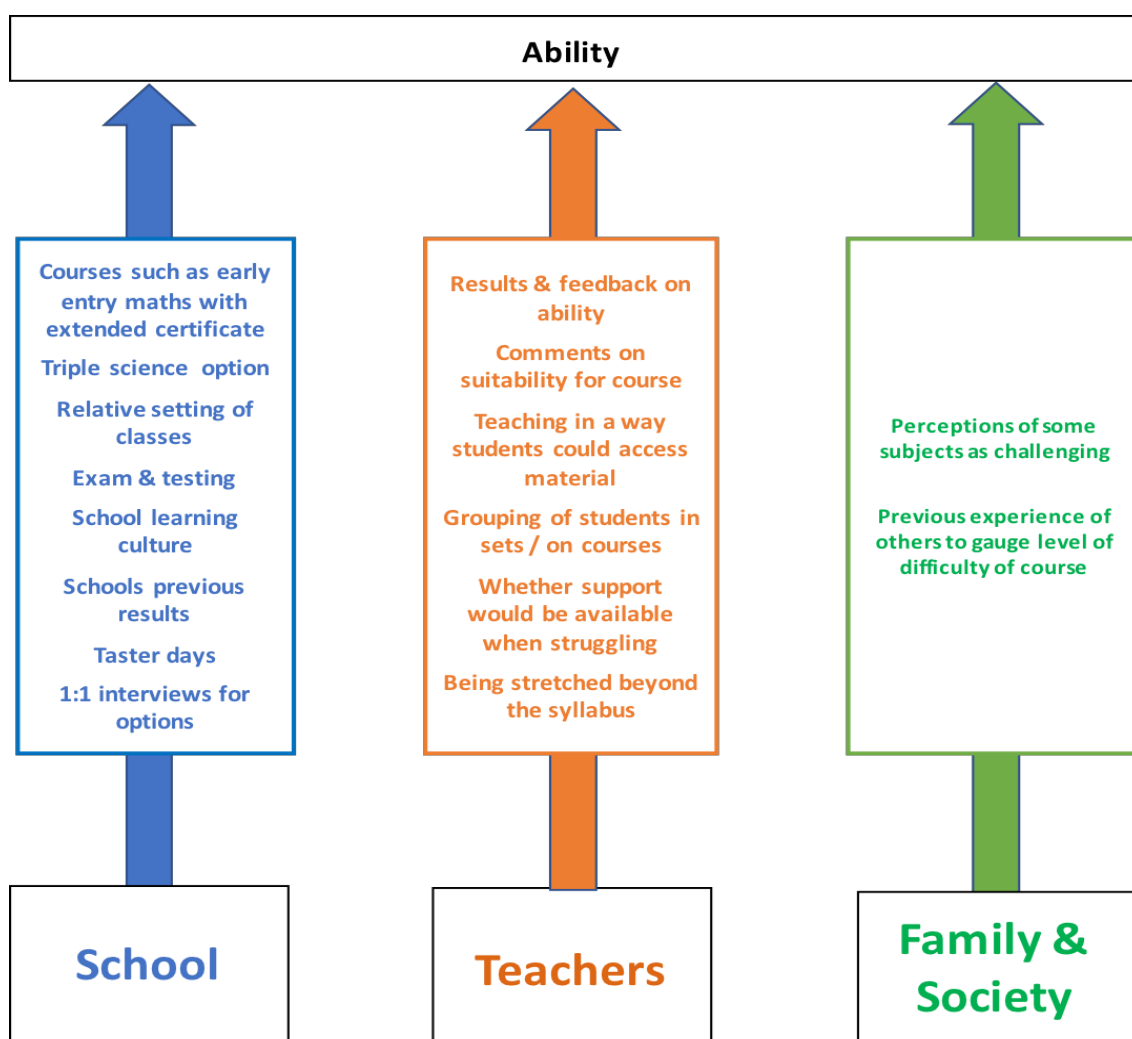


Figure 17 Links that fed into students' perceptions of their ability

The results of the survey showed that students who identified as being good at a subject were more likely to have chosen to study it. The effect was modest for Biology but stronger for Chemistry and Physics. Students were more likely to take a higher number of A-levels if they had a higher average GCSE Science score. While this result is not causal, it does suggest that there is a link and that there is a benefit in understanding what can influence a student’s perception of their own ability. This is in agreement with

findings from Vidal Rodeiro (2007) showing that attainment is a significant influence on a student's choice to take science in the future.

Students' perceptions of their abilities are important. A summary of how the factors linked to their ability is in figure 17. Students who do not believe in themselves as learners are less likely to continue with a task they struggle with (Bandura & Schunk, 1981; Renninger & Hidi, 2011) and may be less likely to choose an A level in Science. As such it is important to know other factors influence their perceived ability, because as pointed out by Renninger & Hidi (2011) self-efficacy can be developed. The factors students mentioned in the interviews are summarised in the diagram below. According to Bandura (1977), students acquire information about their level of self-efficacy from four sources. These are performance accomplishments, vicarious experiences, verbal persuasion, and physiological states. There was evidence of students using a range of these four sources.

Apart from quoting back their attainment at GCSE, students within this sample referred to their ability compared to others within their cohort. This included the set they were in, the course they were studying and for those who had older peers who had completed the course they referred to their experiences to reflect on how their own might be. This is in keeping with findings from Boe et al. (2011) who found that expectations of success are influenced by a student's self-image in relation to the subject. Students also referred to features such as how much effort they needed to put in for the grades they achieved at GCSE and how quickly a concept was understood. Bennett et al. (2011) found that physics was less likely to be chosen by students who referred to it as hard. Conversations with teachers during the lead up to the subject decisions, taster day sessions and 1:1 interviews about option choices seemed to be useful for some students as they explored whether they would be suitable for the course in terms of their ability. These measures were not useful for all students.

There were, however, some experiences which appeared to significantly promote students' self-efficacy and give them more confidence in their abilities. One of these was early GCSE entry. Several students mentioned having completed a GCSE in Mathematics earlier than year 11, and so moving onto more advanced content ahead of their peers. This experience gave some students more confidence to choose Mathematics, and in several cases encouraged some students to study an A-level in Further Mathematics too. With the

number of students who stated the lack of effort required to achieve well at GCSE Sciences. Perhaps moving them on to more higher level content will move them towards attaining and seeing themselves as part of the 'clever core'. Doing so may encourage them towards a stronger subject commitment and a higher level of enjoyment (Matthews & Pepper, 2005). Maybe this idea of entering students when they are ready and then teaching them more challenging content would benefit from further research to see whether it could be a useful tool in removing that 'fixed ceiling' of understanding and encouraging them to continue with the subject beyond year 11. It is worth considering whether schools should adopt early entry for higher attaining students across a broader range of GCSE subjects.

Several students mentioned the nature of assessment in the Physical Sciences and Mathematics as positive because they knew at the end of the problem whether they were wrong or right. According to Bandura's theory (1977), this may have built their self-efficacy through mastery experiences. They also drew comparisons across different subjects regarding difficulty and likelihood of success. Some used this to choose those they were most likely to achieve well in while others preferred a challenge. Several students spoke about avoiding options that carried a higher risk of attaining lower grades. Despite high attainment at GCSE, there was a perception for some students that Sciences were hard and that they were less likely to achieve as highly in the Sciences than they were for other subjects. This is supported by evidence that suggests that the Sciences and mathematics are amongst the hardest subjects to attain the highest grades in (Coe et al., 2008).

Possibly because of this expected difficulty students looked at the quality of teaching to see if they were likely to be supported, if the teacher was approachable, whether they could understand through the classroom teaching, whether they would be stretched and held to high expectations. This alongside watching or learning about the experience of others perhaps helped as a source of verbal persuasion. Together these fed into whether they felt they would be able to succeed on the course (Bandura, 1977). In the context of this study, students gauged their self-efficacy through referring to the ethos and environment of their school and recognising the effect of peer groups, teachers and parents in contributing to this. This included school specialisms, past exam results, targeted interventions and early entries, the level of studiousness, lack of vocational

courses, as well as academic pressure (or arguably high expectations) from parents and staff. For students with lower cultural capital, being part of a school with support in place, good teaching, a track record of good results and having opportunities to speak to students who had already started studying on the courses may have helped to improve students' perceptions of their own success and in doing so develop their self-efficacy.

## Aspirations

The spread of reasons for choosing Science A-levels shows that over one in three students said this was because they needed it for the job they wanted to do, while one in five chose it because they enjoyed it at GCSE. This finding potentially supports findings by Barber (2000), who found that almost half of students who studied A-level Chemistry had chosen it as a stepping stone for a career.

When asked in the survey about when they had reached their decision about which A-level subjects to study, the vast majority of students reported that they reached their decision during year 11, with one in six reporting they made their decision on GCSE results day. This is similar to findings from a survey of more than 3000 15-16-year-old Australian students just after they had made their choices for further study (Lyons & Quinn, 2010). My findings, however, are in contrast with findings from a US-based study by Tai et al. (2006) that showed that decision-making took place much earlier between the ages of 11 to 14. This disparity could be based on the number of decisions that need to be made, as well as the associated deadlines for students. Students, for example, may have decided earlier that they would like to study psychology or medicine but wait until nearer the deadline for submitting options to look at the range of subjects that could help them get there. Another factor that came up through the interviews was an appreciation that students do not make decisions for all their subjects at the same time. Some have a core of subjects that they want to study and may be more flexible when choosing the rest.

An understanding of the factors that may have influenced students' aspirations and supported them towards clarifying them is important. Figure 18 shows a summary of the factors that affected students' aspirations.

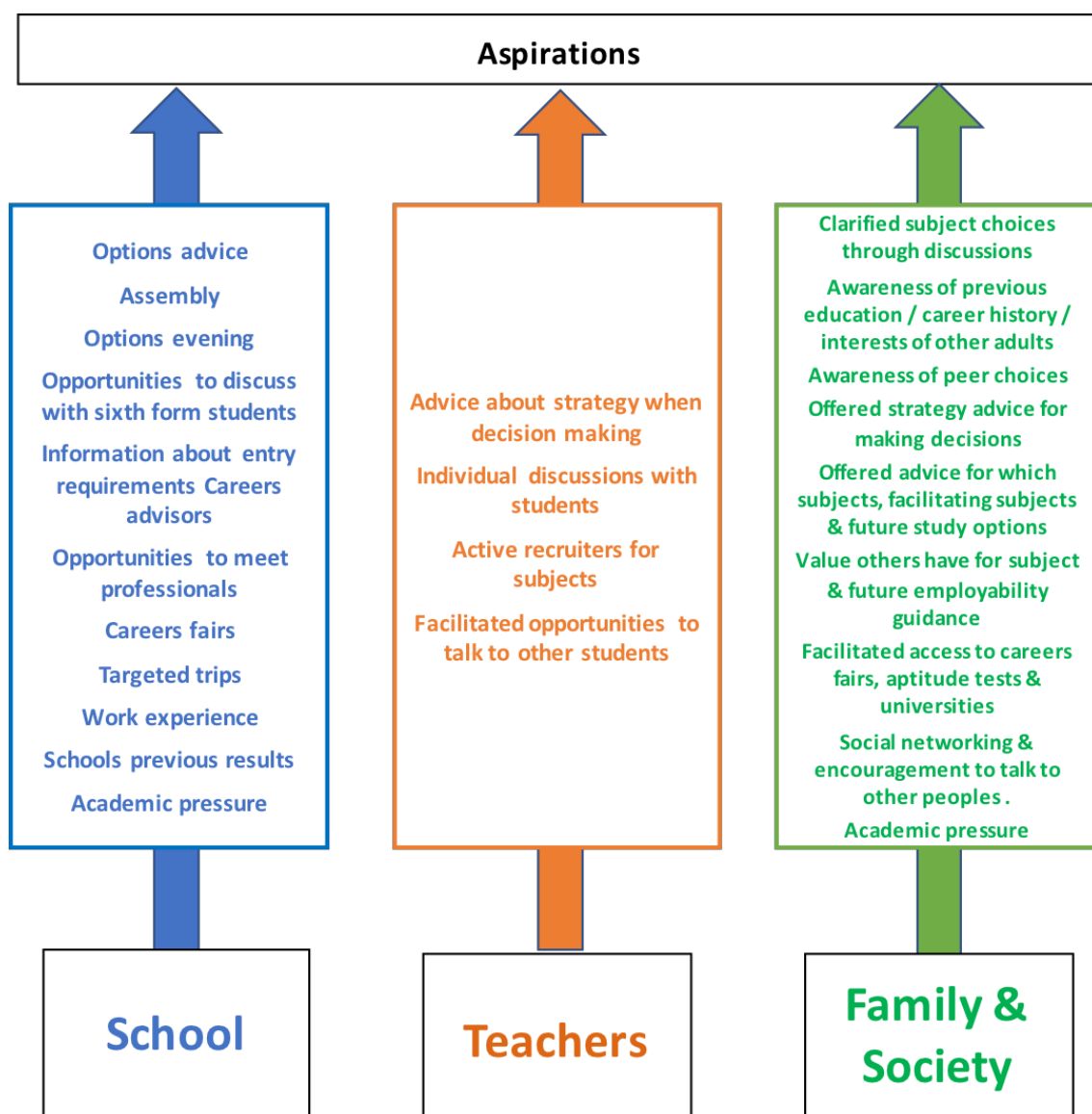


Figure 18 Links that fed into students' aspirations

Most students had some idea of what they wanted to study at university, with most students having looked up possible careers. Some students chose a range of A-levels to manage their workload, develop a range of skills, make them look like well-rounded able learners and improve their chances of employability. Several students considered university perceptions of subjects; this included using the advice regarding preferring facilitating subjects, as well as subjects specified as being looked upon favourably in addition to the entry criteria for students' specific courses. With the government now reporting on the proportion of students in the sixth form who take up two and three facilitating subjects, perhaps there will be a push within sixth forms to encourage students

towards taking more of these, or towards considering them more explicitly while making their A-level subject choices.

Looking at figure 18 it is clear that family and wider society have a significant role to play in helping to shape students' aspirations, particularly when it comes to self-efficacy. Talking to or observing others who have gone through similar experiences is a powerful source in visualising one's own success. This is something schools are also doing through facilitating opportunities to talk to professionals within the field, as well as older peers within the sixth form. Some students gained advice about how to narrow down their options, while others were guided towards careers or subject choices.

Most parents reiterated the focus on careers and university study with some directing their children to university websites and encouraging them to consider employability and others encouraged open discussion to help clarify thoughts. The use of family here is in agreement with the findings from Sjaastad (2012), who highlighted the role of the parents in supporting the study of STEM through interpersonal relationships. While schools have the potential to do similar and offer opportunities for this their success is more questionable because of the limited time and resources and because students, particularly those of higher ability, felt that the discussion centred around confirming their suitability for courses in terms of entry requirements rather than working out a perhaps longer-term vision.

For disadvantaged students with lower cultural capital, they may not have access to the support or experiences of others at home to draw on. As such they may rely more on support within the school in shaping their aspirations. As found in a Norwegian based study of 5000 students by Sjaastad (2012), teachers were influential in subject choices because of their teaching of their subject as well as their interpersonal relationships and the support they offered through the decision-making process. Students within this study shared that they were selective in which teachers they chose to discuss their A-level options with. Some students spoke to the teachers of the subjects they were interested in studying further, while others chose those they had formed positive relationships with. Findings from earlier research had suggested that although students find subject teachers useful for careers information, teachers themselves did not see that as their responsibility (Munro & Elsom, 2000) and were not well informed about careers inside or outside



Science (Stagg, 2007). It cannot be assumed that these findings are still applicable, since the research is now dated. The findings from this project suggest that teachers sharing careers information, feedback on suitability for the course and general advice were important from the student's perspective.

Many of the students mentioned expressing an interest in speaking with a careers advisor but did not have the opportunity to. One student who aspired to go into veterinary Science did manage to book a meeting with one but expressed frustration at his lack of knowledge regarding the particular admissions process. Many of the students in the sample were not able to access an advisor despite wanting to, and those that did get an appointment were not always satisfied with the support provided. Perhaps to prevent such disappointment it could be beneficial for students who are considering a particular career and wanting to discuss it to come to these sessions prepared with the material they had researched and with specific questions. Findings from the recent Wellcome Trust Monitor (Clemence et al., 2013) report that two out of three of young people, aged 14-18, say they know little to nothing about STEM careers, and by limiting their access to careers support and advice they are less likely to gain exposure to this knowledge. Students who have narrowed down their options over time or have narrowed down a career area but not necessarily a high visibility career may need more guidance particularly from teaching practitioners, careers advisors and family in seeking suitable pathways towards those career choices. One current project seeking to address this need is Multi-CO – the project looks at using scenarios to raise career pathway awareness in classrooms within curriculum-based topics. This is based on real-life career experiences of professionals and those within industry. As well developing the understanding of career pathways for teachers and students it also allows them to 'meet' and observe potential role models and so develop self-efficacy through vicarious experiences.

School A had arranged for students to attend two careers fairs. One of these was vocational and so reported as less useful for the sample of students interviewed, perhaps because they were under the impression that vocational pathways were for less able students. The other was more academic but lacked stands for Science careers that interested students, such as medicine and veterinary Science. As a result of the perceived low quality of the event, by the high ability students sampled, some students preferred independent searching online, as well as arranging their own opportunities to engage with

their field. According to a study focusing on lower secondary school students by Archer et al. (2014) only a quarter of students say that their school influences their choice of career, with only one in two hundred students reporting that the school's career education had an influence. My findings related to careers advice are further supported by other studies that have also recognised the patchy nature and quality of careers advice for students in schools (Osborne & Dillon, 2008; Walport, Goodfellow, McLoughlin, Post, Sjøvoll, Taylor & Waboso, 2010; Archer et al., 2016). These findings call for improvements to help students learn about academic and vocational careers within Science as well jobs that they can access through studying Science. This is an area that is being addressed through several projects. One of these was the National Foundation for Educational research which ran case study examples of how Local Authorities (LA's) were supporting schools in the transition of responsibility for careers guidance from LA's to schools (Filmer-Sankey & McCrone, 2012). In addition to this the Gatsby Foundation has issued a report titled 'Good career guidance' (Holman, 2014). Both of these reports highlight areas of good practice and share them with the aim of benefitting the quality of careers guidance in schools.

Two students raised work experience as helpful with both sharing how it enabled them to gain a wider appreciation of Science careers. Given how useful this was for these students, it would be worthwhile trying to support schools in seeking to match students interested in Science with Science-based workplaces. This suggestion is supported by evidence from Bennett et al. (2013) who found that Science work experience placements attended by students while they were in year 10 had a positive influence on uptake of the Sciences. A more recent study by Archer et al. (2015) showed that students who had chosen high visibility careers were often more likely to have spoken to a careers advisor but less likely to have had relevant work experience placements. Perhaps with a wider range of professions and companies available within London it is easier to match students with work experience placements and interactions with relevant people from industry.

This section has shed light on how schools, teachers, families and society within inner London have helped to support students' A level choices. It is hoped that by sharing these findings some elements of good practice can be highlighted which could potentially help practitioners in supporting students as they approach the decision-making phase.

## Research question 2 - Which trajectories did A-level Science students use to decide which A-level subjects to choose?

Looking at the findings, it is clear to see that while the insights into student choices and the links between the factors are more interesting, there is value in the trajectory analysis of overall student choices. Students following direct, partially resolved or funnelling identifier trajectories have actively engaged in their subject choices and are more likely to have made sound decisions. According to Cleaves (2005), this also means they have a stronger subject commitment. In order to help support them in making choices, it is important to empower them by piquing their interest, nurturing a love for learning, developing their perceptions of their ability, promoting their self-efficacy and helping them to decide on a pathway for their future study and careers. As professionals within Science education, part of our role is to help support students into their futures whatever they may be and to empower them to make informed decisions.

Of the trajectories, most commonly used within the purposive sample selected were those that relied on students either aspiring towards careers or areas of future study. This meant that the direct and partially resolved trajectories were followed most often. Students in the main displayed strong subject commitment to those subjects they had researched and knew were necessary as entry requirements for next steps. Of the nine students who had chosen high visibility occupations, six of these had decided on these before their GCSE courses had begun.

Two students followed a multiple-trajectory approach where they changed their minds about their careers. Both of these students mentioned future economic stability as a key factor that led to them adapting their career plans. Students had the option of choosing four A-levels, and universities have some flexibility within their entry requirements, often only requiring between two to three specific A-levels; this meant that there was always some flexibility in choosing between them for students. An example of this is that the entry requirements for a medicine course at one university are for three A grades at A-level. One of the A-levels must be Chemistry, but students also need one of Biology, Physics, Mathematics or Further Mathematics and another rigorous A-level. The range

of factors, discussed above, were used to choose between the exact selection, but for most of the sample, they were using entry requirements to narrow down their subject choices. This meant that as well as having a direct or partially resolved trajectory, they were using the range of factors to make judgements. The factors included what they were interested in, the skills they could gain, their perceptions of their abilities, the university perceptions of subjects, advice from people they had formed interpersonal relationships with and their prior school learning experiences.

Seven students used partially resolved trajectories. These students had a not yet decided on a career but had been looking into potential routes for further study. They had decided on selecting subjects to study for their utility value at higher education. These were subjects that they felt would keep their university options open to them pending a decision nearer the time. One further student developed his choices over time, using a funnelling identifier trajectory, allowing his preference for the subjects to drive forward a career and subject decision based on that. Three of the twenty-two students had not yet considered a career or decided on an area of study and followed their interests and skills for all their subjects.

### **Research question 3 – How are the factors that influence A level subject choices linked to the trajectories followed?**

More important than identifying the trajectories and the number of students who followed each in this study was looking for congruence between the three main factors that influenced student subject choices and the possible link this had towards the trajectories followed. Analysis of the themes within the interviews, alongside the trajectories students followed shows that students are more likely to follow a direct trajectory if they are able, interested and aspire towards a career in Science. The congruence between these factors suggests that Science students choose Science at A-level because they are interested in pursuing Science in later life and are empowered with a sense that they are able to do so.

Some students showed congruence between two factors – either ‘ability and interest’ or ‘aspirations and interest’ or ‘aspirations and ability’. These students were shown to either narrow their choices over time (funnelling identifier) or choose Science because they

were aware of the usefulness of it for future study (partially resolved). Although congruence between two factors may still lead towards the Sciences, some studies looking at wider samples of students have highlighted the instrumental use of A-level Sciences as a potential problem. Some studies have found that despite attitudes to school Science, only the students who need A-level Sciences for further study or careers choose them while others do not (Lyons, 2006a; Stokking, 2000). Their findings support evidence from this study that highlights the prevalent use of direct and partially resolved trajectories. DeWitt et al. (2013) question whether we want students to have an intrinsic value of studying Science or whether we should be interested in how many want it for its value in further education. However, to have such a wide range of students from inner London share that they are doing Science at A-level because of their aspirations is encouraging. For many of them to have considered their aspirations and used them to plan their subject choices, is constructive and may lead to an increasing proportion of these taking up STEM careers; their trajectories suggest that these students were empowered to make informed subject choices.

DeWitt et al. (2013) have shown that interest and positive attitudes in science do not necessarily correlate with science related career aspirations. Greaves et al. (2014) have shown that increased attainment at KS4 in Birmingham and Manchester over a decade, had not correlated with increased participation at KS5. Other researchers have also stated that students with high aspirations can have low progression (DeWitt et al., 2011) and that some students encouraged towards high visibility careers in sciences experience this because their parents and teachers have limited understanding of the range of careers available (Stagg, 2007; Smart & Rahman, 2009). This would strongly suggest that what makes a difference is not focussing on attitudes or interests or aspirations but taking into account all three factors together and using the variety of methods used by the limited control factors influencing them to encourage and to effect change with the aim of increasing the likelihood of students following a direct trajectory.

Foskett et al. (2008) and Bennett and Hogarth (2009) highlight that choice is dynamic, and that young people are continually negotiating new experiences; as such their decision-making processes are open to change. Research question one show that as well as family and wider society influencing these aspects, so can schools and teachers and so there are opportunities to investigate how the examples of good practice highlighted in this project

may be used to promote further study of science elsewhere. Given that this geographical area has been particularly successful in increasing post 16 participation for the disadvantaged perhaps an increased awareness of the support that students may not be getting from family and wider society and allowing the schools and practitioners to help to facilitate opportunities with the aims of promoting students' self-efficacy, interest and career aspirations, as demonstrated in the findings, will help to close the gap elsewhere.

### Limitations of the study

Over the course of this project, there have been some constraints that have limited the outcomes. I had initially aimed for the survey phase to target 300 students from six different schools; this did not happen, for the reasons discussed within the methodology. A lower number of respondents limited the generalisability of the findings from that phase of the study, although the data that collected was still useful in establishing correlations and drawing conclusions (Osborne & Costello, 2004). I could have increased the sample size by being more pragmatic about giving questionnaires to all Science students at the schools and recognising that it was not as important for them to have been from different schools as it was to get a range of different responses from individual Science students. Although the surveys were useful in helping me to identify the interview sample and gain some background understanding of student attitudes, findings would have been stronger with a higher response rate. Future studies could consider administering them online for a larger number of students to access and look at possible incentives for the recruitment phase that would increase the return rate of these.

Another limitation of the use of the questionnaire as an instrument was that it might have reinforced power differences. This power difference occurs because as a researcher I determined which questions would be asked and the nature of the responses required. However, using the combination of the questionnaire with semi-structured interviews may have helped to overcome this by giving more freedom and autonomy to the participant. In addition to this, I am also aware that aspects of my identity, including my gender, age, ethnicity, race, appearance, status and mannerisms may have affected the interactions I had with the students I interviewed. While I tried to minimise any bias in

students' responses based on who I was, this was not always possible, and I was wary of how my role as a researcher may have impacted the interview (Oppenheim, 1998).

Another issue that became apparent was that some students might have been concerned that sharing their avenues of support made them appear weaker, or more impressionable. This was apparent with the repetition of some students of this idea that it was them driving the decision-making process. This sentiment may be positive because it means they have taken responsibility for their choices and are in control of their education, but perhaps this is also a reflection of my wording as it suggests a short-term understanding of the question posed. Maybe some of them felt that being affected by others was a weakness on their part, and this is something I need to reflect on in my wording of the questions. Perhaps when wording the question, I could have asked whether they thought attending a different school may have impacted their choices and in that way encouraged them to look at the specific opportunities and experiences available within their school environment. It would have also been interesting to have explicitly asked the students whether their subject preferences informed their career preferences or their career preferences informed their subject choices.

During the interview, I found that I was asking follow-up questions to elicit a deeper understanding of students' experiences. However, it was clear that the timing of them so close to the MOCK examination results for School A meant that several of the responses from the students were biased around difficulty at A-level, particularly when compared to the GCSE courses. In addition to this, there was one loaded question, and I found myself rewording it during an interview to avoid biasing responses. The question was 'Some of your friends have got good grades in Science at GCSE, yet they have not chosen to study any A-level Sciences, can you suggest why this might be?' While the question was, useful and allowed students to think of particular situations that might trigger more data, it may have been leading and as some students pointed out some of them did not have friends who had not chosen Science, and so this is something I would reword in any future research.

Another limitation of my study was the lack of detail and focus on the students' parents' social, cultural, academic and occupational backgrounds. I chose not to probe this during the interviews, as I was not aware of all students' circumstances and felt it too intrusive.

If students volunteered information related to this, then this was explored. However, my decision to approach the matter in this way limited my understanding of the students' wider Science capital (Archer et al., 2014).

While using the choice framework to identify individual student trajectories, it was not always straightforward. There was difficulty telling the difference between direct and precipitating trajectories. This difficulty was because of how their ideas had evolved with time lacked detail compared to Cleaves study (Cleaves, 2005) where she interviewed 13-year-old students longitudinally until they were 16, and because retrospectively I did not always delve as deeply as I would have liked into how they had decided on their chosen careers. Cleaves focuses on when the decision was made for a future career, and the breadth of careers students were aware of as well as whether they had a deeper awareness of career expectations.

One of the key advantages in looking at the trajectories rather than just individual factors was that it kept intact people's journeys because despite all of the factors identified affecting each student, the way these came together was unique for every individual and this framework allowed an opportunity to appreciate that more. However, in trying to do so, I relied heavily on the students' accounts of how they made their decisions over time which may not necessarily reflect reality. Although students were in year 12 their ability to express themselves, their range of vocabulary and confidence may have been more limited than that of adults. This was one of the reasons why I chose to conduct semi-structured interviews and probed for a deeper understanding. The primary focus of the conversation was, however, asking students to remember why they had made decisions in their past. Young people's memory is less developed than adults, and so some of them may have been unable to recall in detail relevant material when asked during the interview – this introduces recall bias (Hassan, 2006). The sharing of the pre-prepared questions both verbally and in writing aimed to help minimise this but it could not be eliminated.

If I were doing this study again, I would do at least three interviews with students one at the beginning of year 10, another before their A-level choices were due, and the last at the beginning of year 12. In doing so, I could bring up any changes they had made to their options and then perhaps the subsequent discussions may be more accurate regarding the transition of choices over time. I began to appreciate through the interviews and data



analysis that it was more than just one decision that students were making. Each subject they decided to take or not take further was a decision, the location of where they were going to study as an institution was a decision, the way they were going to approach the decision-making process was a decision and looking at the overall package of A-levels they would have studied were also decisions. I applied a best-fit model to identify trajectories, which was useful because as well as the process being rich through time and factors, it is also involved several decisions being made at a similar time.

### Original contributions of the study

This study contributes to the literature exploring the educational choices of students who opt to study Science after the compulsory phase. It did so in an ethnically and socioeconomically diverse geographical area, inner London, that had been highlighted for closing the attainment gap between students with free school meals and those without, as well as translating that into higher levels of participation in the post-compulsory phase. The first original contribution of the study is the focus of the study solely on inner London Science A level students. Researching this unique context was important as it may allow other schools to benefit from the experiences shared, and perhaps offer insight into strategies that may be used to improve upward social mobility through a better understanding of the choice process. Inner London was identified as an area that increased student's educational participation at key stage 5. In doing so, it succeeded in removing some of the barriers students face and so increasing their life chances through improving their education. Exploring how they did this in this area enriches the existing knowledge base as other practitioners working in cities facing similar barriers may benefit through the transferability of the findings.

The subject area studied has attracted a wide range of research approaches, including use of large-scale databases and longitudinal quantitative and qualitative studies. Researchers have advocated conducting qualitative investigations to develop a deeper understanding of the students' experience in Science. This study is unique as it focuses on students who have opted for Sciences and looks at the qualitative factors that have affected their educational choices, using a choice framework that looks at decision-making retrospectively. This mixed methods research, therefore, presents a new evidence base of

how Science students make their A-level subject choices and the factors that have affected them. It also allows for a greater degree of understanding of the selection process through identifying how, why and when factors can affect students, as well as looking at the range of trajectories students take that lead them towards Science pathways.

I argue that the model developed in this study is another unique contribution, in that it comprehensively brings together the factors that affect Science student's choices, the relative links between the factors and the resulting trajectories followed towards the Sciences. Cleaves trajectory model has been used by other researchers (Ametller & Ryder, 2015) and been found to be useful. Similar to this study the researchers used the model retrospectively although they reconfigured the definitions slightly to identify driving forces behind decisions and to allow it to fit better with their data. While this suited the researchers, it was not necessary in this context as the analysis of themes underlying the trajectories allowed for a richer exploration between the factors and the trajectories explored. They map their trajectory based on the main driving forces of choice being the balance a student finds between career or topics. In contrast the model developed in this project does not assume that all variables are important for all students, but it does show how they could come together to support a student's decision-making.

This model has the potential to offer valuable insight and clarity to educators, which would better enable them to address obstacles to choosing Science. This study goes beyond identifying factors. It has done this by classifying factors according to the degree of control students have on them, then looking at links between the factors and mapping them to the type of trajectory used by students. It suggests that support in place for students needs to look beyond stimulating interest. Instead, students may benefit from a three-pronged approach looking at developing congruence between their interest, ability and aspirations. It also looks at how these three main factors can be affected and influenced by teachers, the school and wider society. It reiterates that although gender and socio-economic factors may affect student's decision making towards the Sciences they do so through affecting their aspiration, interest and perceptions of their own ability. I suggest that efforts to improve Science participation are more likely to be effective if they focus on developing greater congruence between those factors which would in turn increase the likelihood of a direct trajectory being used.

One of the long-term aims of updating the Science curriculum was to stimulate interest and the ‘wonder’ of students thus increasing the proportion of students who wished to study Science further and so increase the uptake of STEM subjects at university. Many of the changes in the past ten years have centred on catering for the scientific literacy of the majority of students in the UK who do not go on to further study of Science. This study gave a voice to those students who do want to continue the study of Science and allowed their voice to be heard. This study was about more than identifying factors; it looked deeply at how these factors affect Science students in different ways and the overall strategies they use to help them move forward at key points of their lives. Both schools in the study put in place opportunities for year 11 students to speak to older sixth formers and learn from their first-hand experiences. The study took a purposive sample of A-level Science students and rather than look for general patterns and trends that unified them, looked at the subtleties in their individual stories with the aim of supporting and guiding the next generation given their experiences. The final original contribution of this study, therefore, is the use of inner London A-level Science students’ retrospective insights to understand and potentially develop the student experience further.

### **Implications & recommendations for professional practice**

This project complements larger scale projects analysing participation rates in secondary Science by developing the ‘story’ behind national trends and subject selection patterns within a local authority in inner London. The findings may allow the policy makers and stakeholders of further education to plan useful support and information sharing opportunities to help students, particularly the disadvantaged, through their decision-making at the points of time when they matter most to the students

The three most important factors that influenced student’s subject choices were their interest in the subject, their ability and their aspirations. Research has shown that interest in Science alone is not sufficient (DeWitt et al., 2013). Student uptake statistics have demonstrated that attainment alone is not sufficient (Greaves et al., 2014). Aspirations without interest or ability are not well founded. In terms of implications for professional practice, results from this study suggest that efforts to increase uptake need to target all three of those factors.

A student's perception of their ability, self-efficacy, was found to be a key factor in their subject selection. Students shared that they gain their perceptions of their ability from multiple sources including teachers, assessment results, advice from other people and amount of effort they need to put into their work. I recommended that strategies are put in place to nurture female students' perceptions of their ability in Physics. This would be a learning culture where resilience is expected and encouraged as part of the learning journey. There are examples of initiatives that promote this growth mindset and have been shown to effectively impact on maths and science achievement (Dweck, 2014; Yeager, Romero, Paunesku, Hulleman, Schneider, Hinojosa, Lee, O'Brien, Flint, Roberts & Trott, 2016).

One of the key factors that encouraged students to take up further mathematics alongside mathematics at A-level was the opportunity for early entry before their peers and the opportunity to do more advanced mathematics in year 11. Many of the students referred to the ease of passing their GCSE Sciences and the difficulty of the transition to A-level Sciences. A recurring comment made throughout the interviews was that students liked to be challenged beyond the scope of the curriculum, and liked the greater depth teachers covered. Perhaps encouraging schools to enter students early for Science examinations, or increasing the rigour of the content taught beyond the scope of the GCSE curriculum, could act as a bridge to the A-levels. This rigour may encourage more students, particularly those that are able, towards further study of Science, and allow more of them to see Science as part of their future in the lead up to post-compulsory subject choices.

There are several things schools could do to promote self-efficacy for science study with a particular focus on the underrepresented or disadvantaged. Schools could assign students a learning coach or mentor so students have a point of contact with someone where they can share their interests and explore their aspirations. This person could also help them navigate what they need to do to get there. Some students may not have access to people within the field they are interested in, so talking to students who are currently pursuing courses they are interested in would be useful to discuss difficulty of course, share experiences and expectations. Having access to a social network of alumni where students can connect with role models within the professional field and gain insight into

employability, awareness of career progression; this may help to motivate them and develop their self-efficacy.

Many students were let down by lack of access to a careers advisor, as well as not being able to talk to Science professionals at careers fairs or work experience placements. For underrepresented and disadvantaged students, this is vital as they may not have support outside the school to compensate for this. This would suggest that the quality of careers fairs needs to be improved, with a particular focus on ensuring there are opportunities to engage with professionals from the field that a student expressed interest in. I believe that it is important that planned opportunities for Science specific careers support are available to students who need it. Most students spoke of having made their decision for most subjects before attending A-level information evenings, so perhaps their role in subject recruitment is limited, and there could be other opportunities planned earlier in secondary schooling that could be more efficient. I suggest that local authorities could work together with industry specialists to seek and ensure these opportunities are periodically available and advertised for schools in their geographical areas to access. This collaboration could be an annual Science careers fair, or a database of pre-approved Science specialists offering work experience placements that schools in the area can access. While it may take some time and resources to invest in setting these up, this would mean the quality of what is available to aspiring scientists is more suited to their needs.

Finally, one of the key factors for STEM students was found to be that of the interpersonal relationships through which parents and teachers supported and advised students. Perhaps it would be useful to target family and teachers in initiatives to increase the recruitment of STEM subjects when sharing information about subject choices and career pathways. There is a UK based websites that targets parents and advises them on how to best support their child (e.g. [www.careersadviceforparents.org](http://www.careersadviceforparents.org)). It may be beneficial to signpost these and share selection strategies and underlying factors, as well as the range of ways that students are supported by stakeholders explicitly. Increasing awareness of how students reach their A-level subject choices, with students themselves as well as with those who support them may help to steer them through the selection process better. Having an increased consciousness of avenues of support and how they fit into the bigger picture may allow students to make more informed decisions about their future and empower them to seek support from avenues they may not have considered. It would also enable

teachers and parents to see their role in the 'bigger picture' so they are aware of how they are supporting the student more holistically throughout their schooling.

## Further work

The first suggestion for further work would be to test the model developed to see how transferable it is to other contexts, and possibly other academic subjects. It would be beneficial to examine how comprehensive and inclusive the model developed through this study is by testing it within a bigger sample of students across a wider range of schools in a broader variety of contexts.

Due to workload and access, there was a small sample used in the study, and each student was interviewed once. Methodologically, future research could explore how links between the factors evolve over-time using periodic interviews across a student's schooling. It would be useful to learn whether students are more likely to be influenced by particular factors at specific times, compared to others. A longitudinal study may help researchers gain further insight into time appropriate interventions for students that fit into the reality of their everyday school experiences. This is currently an area that is being researched by ASPIRES 2, more information should be available soon about how students develop their career goals and the variables that affect their career choices.

Further studies could also focus on speaking to parents of students who have chosen to pursue Science. Such projects would allow researchers to gain insight into parents' perspectives on how their child's interests developed over time, as well hear from them about the type of support they feel would have been of benefit. It would also allow more of an opportunity to understand how parents' academic, cultural and occupational backgrounds, a significant part of an individual's 'Science capital', could have affected students (Archer et al., 2014).

Finally, a quasi-experimental study could take place that looks at the impact of accelerating highly able students through GCSEs into A-levels and the impact this has, if any, on subject choices after the post-compulsory phase. This type of project would need

careful consideration and planning, to take into account wider effects for any children involved and whether it would be in their best interests.

### Closing remarks

While there is a range of themes that feed into a student's subject choices this study shows that they are primarily effective because they all feed into three main areas. These are the areas that need to be targeted to improve uptake of the Sciences. The first is students interest in Science – a personal interest in studying Science. The second is a student's ability –their actual attainment, as well as their perception and confidence in their abilities. The final is their Science-related aspirations for the future.

All the themes discussed in the project show direct links to these three factors. Of the school-related factors most useful to students when making decisions about their subject choices are those associated with the overall experience of students through their schooling. The most valuable experiences were their day-to-day Science lessons, their final attainment in their subject and the interpersonal relationships they build with teachers over time. Options evenings, taster sessions and work experience placements are much less useful in comparison when it comes to subject choices. Most students claim they are pursuing Science primarily because it is what they want to do for the future or for careers they have chosen or are considering. Most of those students sampled recognise the value of studying Science in society and have positive experiences of it at GCSE. While some refer to parents as helping to guide them or instilling values about Science, parents did not impose particular choices onto their children.

Student interest in Science has already been the centre of much research and is not a limiting factor for subject choice – however, this study suggests that there is a benefit in addressing its congruence with a student's ability and aspirations. This study suggests that higher attaining students may benefit from increasing the level of learning and challenge earlier through the GCSE process, as this may increase the chances of them recognising their own ability and joining a more advanced Science learning community. In addition to this, it highlights the benefits of well-founded career aspirations in Science, especially in the midst of other factors that could affect choice. It also emphasises that

taster sessions need to be realistic if they are to be useful for students and that earlier career advice and exposure is vital if it is to be effective and helpful for students in their choices. Addressing the issue of Science uptake through developing all three areas (interest – ability – aspiration) should empower more students to follow a direct trajectory and pursue further study of Science and related careers.



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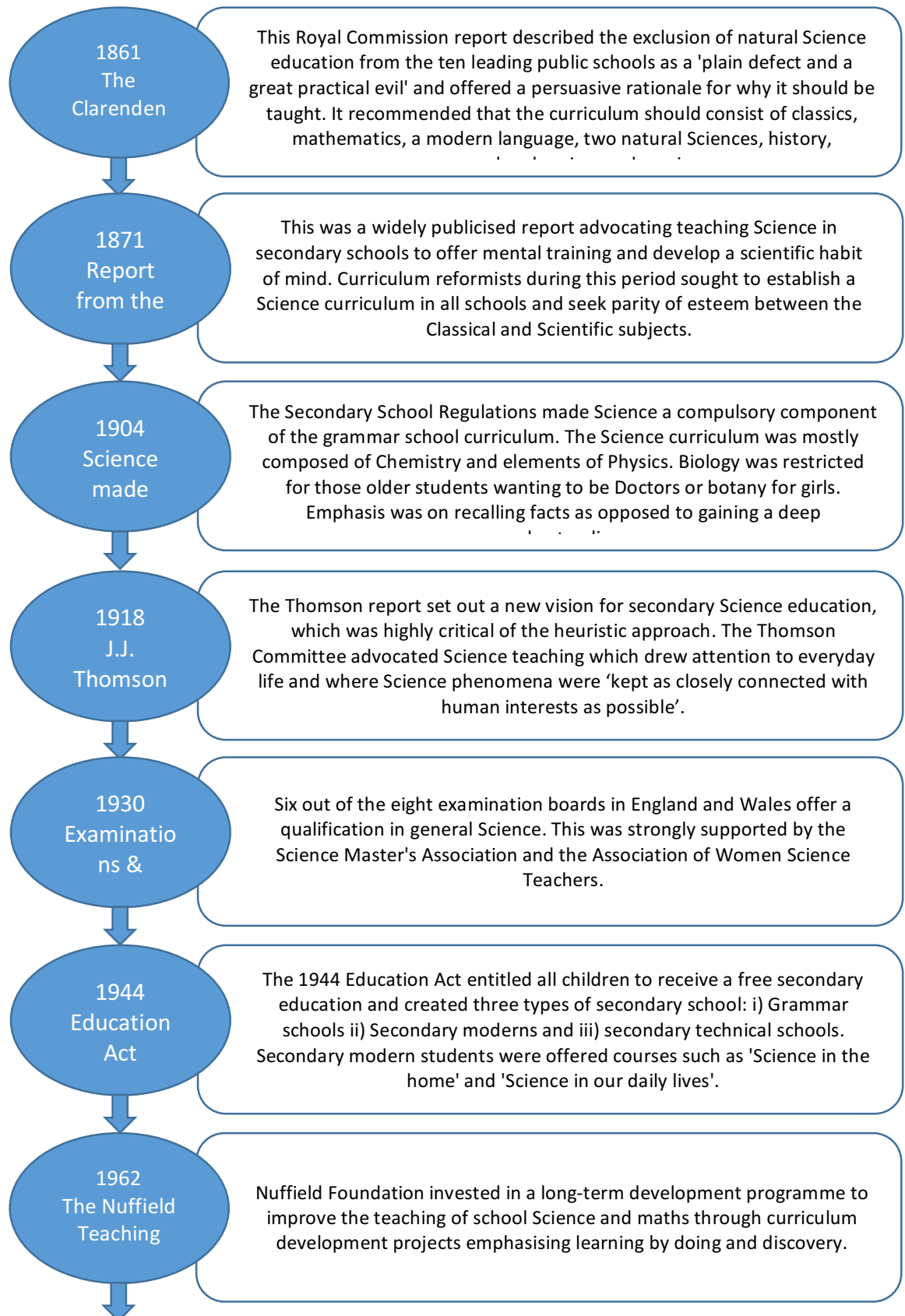
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## Appendices

### Appendix 1 - Key Dates within Science education



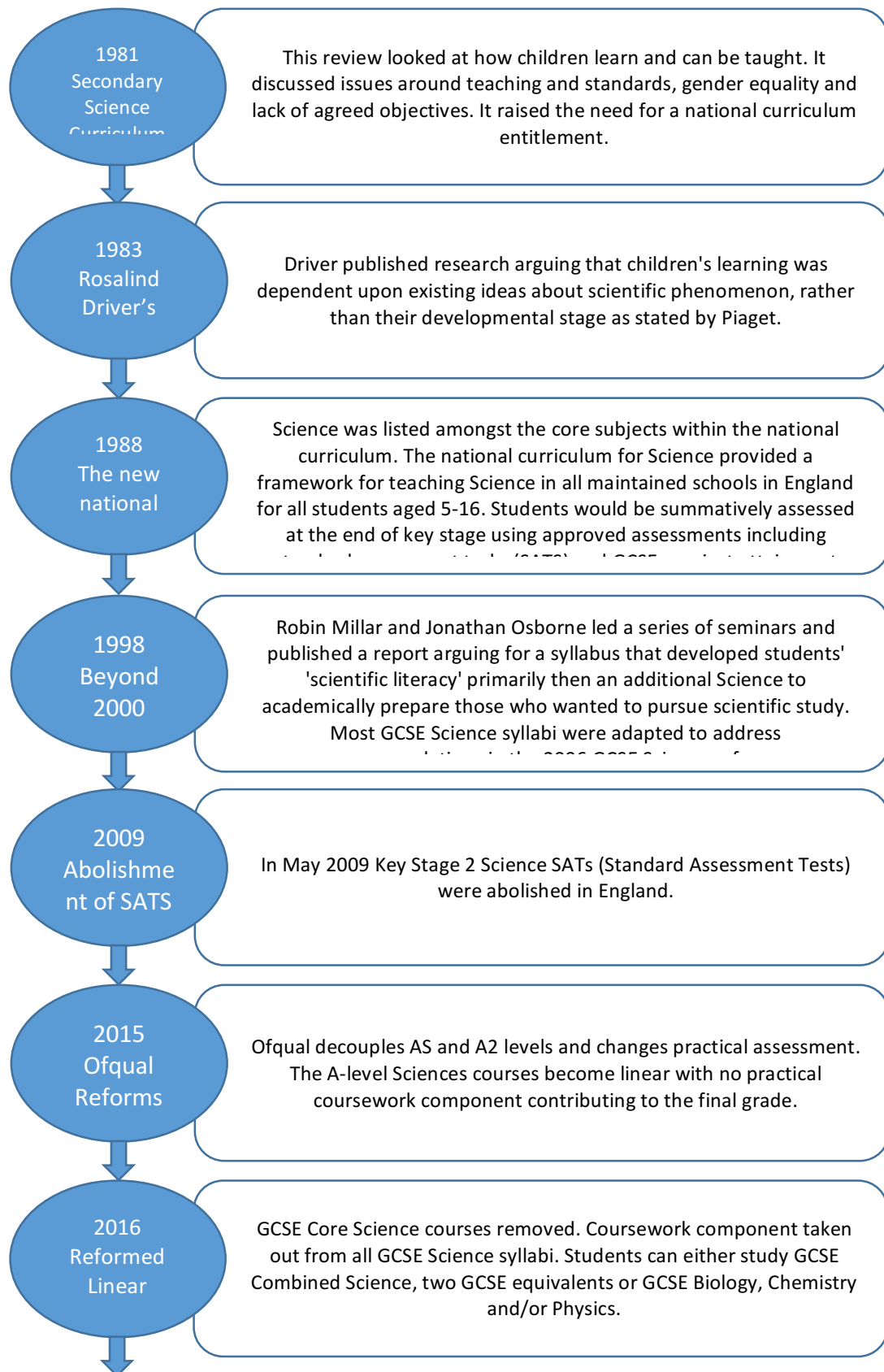


Figure 19 Adapted timeline of the history of Science education (Gillard, 2011)

## Appendix 2 - Information and consent forms for first and second phase

### INFORMATION SHEET FOR PARTICIPANTS – 1<sup>st</sup> phase

REC Reference Number: REP(EM)/12/13-61

**YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET**



#### **An exploration of attitudes to Science and factors that affect students' uptake of A-level Sciences – a case study approach**

I would like to invite you to participate in this postgraduate research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please take the time to read the following information carefully and discuss it with others if you wish. Contact me if there is anything that is not clear or if you would like more information.

The aim of the study is to explore student attitudes to Science and examine the factors that affect a student's uptake of A-level Sciences.

Up to fifty year 12 students will be invited to complete questionnaires about their attitudes to Science. If you would like to contribute further, please leave your full name on the questionnaire and you may be invited to take part in a follow up interview.

Taking part in the project will mean you have the opportunity to contribute to current educational research, help enhance our understanding of student's perceptions of Science and allow us to gain an insight into what factors can affect A-level choices. A final report will be available for all participants. If you do decide to take part, you will be given this information sheet to keep. If you agree to take part your data will be kept securely and anonymised.

If you have filled in the questionnaire anonymously, you cannot withdraw your data once it has been submitted. If you have supplied your name you can withdraw yourself from the study, at any stage. In addition to withdrawing yourself from the study, you may also withdraw any data/information you have provided up until 31<sup>st</sup> January 2014, when the data will be anonymised and analysed for use in the final report. A decision not to take part will not affect the standard of care or teaching you receive, and you do not need to give a reason for your decision.

This research is being conducted by Marwa El-Damanawi, [marwa.el-damanawi@kcl.ac.uk](mailto:marwa.el-damanawi@kcl.ac.uk), a doctoral student at King's College London, Waterloo Bridge Wing, Franklin-Wilkins Building, 150 Stamford Street, London SE1 9NH, United Kingdom

If this study has harmed you in any way you can contact Professor Justin Dillon for further advice and information, at [justin.dillon@kcl.ac.uk](mailto:justin.dillon@kcl.ac.uk), or Department of Education and Professional Studies, King's College London, Waterloo Bridge Wing (Room 1/7), Franklin-Wilkins Building, 150 Stamford Street, London SE1 9NH, United Kingdom

## INFORMATION SHEET FOR PARTICIPANTS – 2<sup>nd</sup> Phase

REC Reference Number: REP(EM)/12/13-61

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET



### **An exploration of attitudes to Science and factors that affect students' uptake of A-level Sciences – a case study approach**

We would like to invite you to participate in this postgraduate research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please take the time to read the following information carefully and discuss it with others if you wish. Contact me if there is anything that is not clear or if you would like more information.

The aim of the study is to explore student attitudes to Science and examine the factors that affect a student's preparation for and uptake of A-level Sciences.

Up to 50 year 12 students were invited to complete questionnaires about their attitudes to Science. You have volunteered and been selected to take part in the second phase of the project, which will involve a semi-structured interview, lasting approximately 20 minutes.

Taking part in the project will mean you have the opportunity to contribute to current educational research, help enhance our understanding of student's perceptions of Science and allow us to gain insight into what factors can affect A-level choices. A final report will be available for all participants.

If you do decide to take part, you will be given this information sheet to keep and will be asked to sign a consent form. If you agree to take part your data will be kept securely and anonymised. Interviews will be recorded, subject to your permission and the recordings of interviews will be deleted upon transcription.

If you decide to take part, you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care or teaching you receive. In addition to withdrawing yourself from the study, you may also withdraw any data/information you have already provided up until 31<sup>st</sup> January 2014, when it will be transcribed for use in the final report.

This research is being conducted by Marwa El-Damanawi, [marwa.el-damanawi@kcl.ac.uk](mailto:marwa.el-damanawi@kcl.ac.uk), a doctoral student at King's College London, Waterloo Bridge Wing, Franklin-Wilkins Building, 150 Stamford Street, London SE1 9NH, United Kingdom

If this study has harmed you in any way you can contact Professor Justin Dillon for further advice and information, at [justin.dillon@kcl.ac.uk](mailto:justin.dillon@kcl.ac.uk), or Department of Education and Professional Studies, King's College London, Waterloo Bridge Wing (Room 1/7), Franklin-Wilkins Building, 150 Stamford Street, London SE1 9NH, United Kingdom



## CONSENT FORM FOR PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.



### Title of Study:

An exploration of attitudes to Science and factors that affect students' uptake of A-level Sciences – a case study approach

King's College Research Ethics Committee Ref: REP(EM)/12/13-61

Thank you for considering taking part in phase two of this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

Please tick  
or initial

- I understand that if I decide at any time during the research that I no longer wish to participate in this project, I can notify the researcher involved and withdraw from it immediately without giving any reason. Furthermore, I understand that I will be able to withdraw my data until 31st January 2014, when it will be transcribed for use in the final report.
- I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the Data Protection Act 1998.
- I consent to my interview being recorded.

☐☐☐

### Participant's Statement:

I \_\_\_\_\_

agree that the research project named above has been explained to me to my satisfaction and I agree to take part in the study. I have read both the notes written above and the Information Sheet about the project, and understand what the research study involves.

Signed

Date

### Investigator's Statement:

I, Marwa El-Damanawi, confirm that I have carefully explained the nature, demands and any foreseeable risks (where applicable) of the proposed research to the participant.

Signed

Date

## Appendix 3 - Student Survey Questionnaire

### Science and you: How does Science fit into your life?

I am interested in finding out about your views on Science as part of a survey of year 12 students in this school. I am very keen to know what you think about Science in school, your own interest in Science and Science and society.

### Some background information about you

Gender

☐ Male

☐ Female

Ethnicity

White	<input type="checkbox"/> English <input type="checkbox"/> Other British <input type="checkbox"/> Irish <input type="checkbox"/> Any other white background (please specify) _____
Mixed	<input type="checkbox"/> White & Black Caribbean/African <input type="checkbox"/> White & Asian <input type="checkbox"/> Any other Mixed background (please specify) _____
Black or Black British	<input type="checkbox"/> Caribbean <input type="checkbox"/> African <input type="checkbox"/> Any other Black background (please specify) _____
Asian or Asian British	<input type="checkbox"/> Indian <input type="checkbox"/> Pakistani <input type="checkbox"/> Bangladeshi <input type="checkbox"/> Chinese <input type="checkbox"/> Any other Asian background (please specify) _____
Other Ethnic Group	<input type="checkbox"/> Other Ethnic background (please specify) _____

Father's occupation / educational background

\_\_\_\_\_

Mother's occupation / educational background

\_\_\_\_\_

GCSE Science grade(s) achieved:

Core Science \_\_\_\_\_

Additional Science \_\_\_\_\_

OR Biology \_\_\_\_\_

Chemistry \_\_\_\_\_

Physics \_\_\_\_\_

GCSE Mathematics grade: \_\_\_\_\_

GCSE Science syllabus studied:

☐ AQA

☐ OCR

☐ Edexcel

☐ Other, please state

\_\_\_\_\_

Did you take your GCSEs at this school?

☐ Yes      ☐ No

Which subjects are you currently studying at AS:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

When did you decide which AS levels subjects you would be studying?

- ☐ Year 6 or before
- ☐ Year 9 or before
- ☐ Year 10
- ☐ Year 11
- ☐ After GCSE results day

When completing this section of the questionnaire, you are given statements. Use the scale above to decide how you feel about each statement.

How important were the following persons in choosing your course?

	Not very important	Not important	Undecided	Important	Very important
<i>Mother or Step mother</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Father or Step father</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Good teachers</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Friends (including girlfriends or boyfriends)</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Siblings or other relatives</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Careers advisors in schools</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Other person. Who?</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**How important was each of the following school experiences in choosing your course?**

	Not very important	Not important	Undecided	Important	Very important
<i>Your interest in the subject</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Your previous attainment in related subjects</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Experiments/laboratory work</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Field work or trips</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Lessons showing the relevance of your subject to society</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Lessons showing practical applications of your subject</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Using mathematics in lessons</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Clear feedback on whether you got the right answer</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Going to a careers fair</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Researching on your own</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Doing an online careers aptitude test</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Taster sessions</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Work experience placement</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Have you decided which career you would like to pursue?**

☐ Yes

☐ No

☐ I have an idea

**If yes, which area are you interested in and when did you begin considering this?**

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How much do you agree with the following statements?

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
<i>Advances in Science and technology usually bring social benefits</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>I enjoy acquiring new knowledge in Science</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Science is useful to me</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Science is useful for further studies</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>I would like to work in a career involving Science</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>I would like to spend my life doing advanced Science</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>I regularly watch television programmes about Science</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>I regularly visit websites about Science</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>I regularly borrow books on Science</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>I am good at Chemistry</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>I am good at Biology</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>I am good at Physics</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>The way Science is taught in lessons makes it interesting for me</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

For this next section, you need to first decide whether you agree, neither agree nor disagree or disagree with each statement. You then need to choose from the list below the reason that best explains your view.

#### A Science in school

##### A01 At GCSE Science lessons were among my favourite lessons

I agree because...		I neither agree nor disagree because...		I disagree because...	
a	...I liked the topics we studied	k	...it depends on what we were doing	p	...I didn't like the topics we studied
b	...I found the topics we studied easy	l	...Science lessons were nothing special	q	...I found the topics we studied hard
c	...I liked being able to put my own ideas forward	m	...I was not really into being at school	r	...I didn't like discussions
d	...I liked the discussions we had	s	...I would have preferred to do more practical work	t	...what we did was boring
x	... another reason - please say what	y	... another reason - please say what	z	... another reason - please say what

##### A02 When I had a choice after GCSE, I chose at least one Science subject.

I agree because...		I neither agree nor disagree because...		I disagree because...	
a	...I need them for the job I want to do			p	...you don't need Science subjects for the job I want to do.
b	...I wanted to take Biology			q	...Science subjects are hard
c	...I wanted to take Chemistry			r	...I didn't see the point of the things we did in Science
d	...I wanted to take Physics			s	...Science subjects involve too much work
e	...my parents wanted me to take one or more Science subjects			t	...Science subjects aren't cool
f	...I really enjoyed Science lessons at GCSE			u	...I can get a better grade in other subjects
x	... another reason - please say what	y	... another reason - please say what	z	... another reason - please say what

**A03 What we do in Science lessons is useful whatever you do after you leave school.**

I agree because...		I neither agree nor disagree because...		I disagree because...	
a	...studying Science helps people understand the world they live in	k	...Science is no more or less useful than any other subject	p	...most of your life you can get by with common sense, so you don't need Science
b	...Science affects so many things in everyday life	l	...it depends on what you do when you leave school	q	...knowing about something may not change how you behave, e.g. smoking and lung cancer
c	...knowing about Science and how it works helps you make better decisions about some things			r	
x	... another reason - please say what	y	... another reason - please say what	z	... another reason - please say what

## **B Your own interest in Science**

**B01 I like watching Science programmes on the TV.**

I agree because...		I neither agree nor disagree because...		I disagree because...	
a	...they make me more interested in Science.	k	...Science programmes are no more or less interesting than other programmes.	p	...I would never watch a Science programme on TV.
b	...they help me understand the Science we do at school.	l	... I like them only if they are about wildlife.	q	...I never watch TV.
c	...I like seeing how Science is used in the real world.	m	... I like them only if they are about Science fiction.	r	...they present scientists in a stereotyped way, such as men wearing white coats.
x	... another reason - please say what	y	... another reason - please say what	z	... another reason - please say what

**B02 I would trust something a scientist said.**

I agree because...		I neither agree nor disagree because...		I disagree because...	
a	...scientists are respected members of the community.	k	...it depends on who the scientist is.	p	...scientists alter the results from their experiments.
b	...it is part of their job to care about things.			q	...scientists confuse people with long words.
c	...scientists are intelligent people.			r	...they might get things wrong.
d	...scientists have expert knowledge.			s	...scientists always seem to be arguing about things.
				t	...they don't care about the truth, they just want to be famous.
				u	...they don't always tell people what they have a right to know.
x	... another reason - please say what	y	... another reason - please say what	z	... another reason - please say what

**B03 It would be good to have a job as a scientist.**

I agree because...		I neither agree nor disagree because...		I disagree because...	
a	...I would like to work in a laboratory.	k	...it depends on the particular job that you would do.	p	...scientists do boring jobs.
b	...scientists do many different types of jobs.	l	...I don't know much about what scientists do.	q	...scientists are generally not well paid.
c	...scientists do interesting jobs.			r	...scientists are a bit weird.
d	...scientists are generally well paid.			s	...scientists try new things without thinking about the risks.
e	...scientists are people who can change the world for the better.			t	...scientists have to make too many compromises.
				u	...people see scientists as causing problems in the world.
				v	...scientists care more about Science than people.
x	... another reason - please say what	y	... another reason - please say what	z	... another reason - please say what



## C Science and society

### C01 Science has a positive influence on society.

I agree because...		I neither agree nor disagree because...		I disagree because...	
a	...Science has given society things like cars, computers and TVs.	k	...scientists tend to do what they want and don't always have a good effect.	p	...what happens in Science has very little to do with society and everyday life.
b	...Science has made medical breakthroughs (e.g. finding cures for diseases and transplant surgery).	l	...it depends on the country you live in, Science is of more benefit in developed countries.	q	...Science has gone too far and is trying to control our lives.
c	...Science makes life easier (e.g. Hoovers, washing machines and telephones).			r	...you just have to look at some of the things that Science has done, such as nuclear weapons and pollution.
d	...Science makes life safer (e.g. air -bags in cars).			s	...Science creates more problems than it solves.
e	...scientific theories can change the way people think (e.g. evolution).			t	...a lot of scientific research is used for hi-tech weapons.
f	...Science is about solving the problems in society.			u	...scientists don't always consider the ethics of what they are doing.
g	...Science creates jobs.			v	...it can be dangerous to live near things like nuclear power stations.
				w	...Science is getting out of control and there is nothing we can do to stop it.
x	... another reason - please say what	y	... another reason - please say what	z	... another reason - please say what

**C02 Science makes an important contribution to the wealth of the nation.**

I agree because...		I neither agree nor disagree because...		I disagree because...	
a	...Science helps create jobs.	k	...I don't know enough about this.	p	...as Science solves problems, it just creates more problems to solve and that costs more and more money.
b	...without Science we would not have any industry to make money for the country.			q	...Science is not about money, it is about finding things out.
c	...without Science there would not be discoveries that might make money.			r	...most jobs do not involve Science.
d	...Science leads to inventions, which people then buy.			s	
x	... another reason - please say what	y	... another reason - please say what	z	... another reason - please say what

**C03 It is important for this country to have well-qualified scientists.**

I agree because...		I neither agree nor disagree because...		I disagree because...	
a	...scientists are needed for developments in areas such as medicine.	k	...scientists are no more important than other groups of people.	p	...they do more harm than good.
b	...scientists in this country can help other countries.				
c	...they help make the country a better place to live in.				
d	...scientists can help Government make the right decisions, e.g. about the environment.				
x	... another reason - please say what	y	... another reason - please say what	z	... another reason - please say what

**04 People who do not know much Science are at a disadvantage in today's society.**

I agree because...		I neither agree nor disagree because...		I disagree because...	
a	...it means you won't be able to understand things you see on the News or in papers (e.g. cloning).	k	...I don't think it makes much difference either way.	p	...scientists get things wrong so knowing about Science isn't much help.
b	...if you don't, scientists could fool you about things because you don't understand what's going on.			q	...lots of people manage to get on in society without knowing much Science.
c	...knowing some Science can help you get a job.			r	...it's not very cool to be into Science.
x	... another reason - please say what	y	... another reason - please say what	z	... another reason - please say what

If you would like to participate further through volunteering for a one to one interview, could you please fill in the details below:

Full name \_\_\_\_\_

Tutor group \_\_\_\_\_

School \_\_\_\_\_

How would you prefer to be contacted? \_\_\_\_\_

Contact details \_\_\_\_\_

Returning a completed questionnaire implies your consent to participate in this research; your information will be treated as strictly confidential and handled in accordance with the Data Protection Act 1998.

**THANK YOU FOR SHARING YOUR VIEWS & TIME!**

## Appendix 4 - Interview schedule

### Interview schedule – Year 12 students

Thank you for agreeing to talk to me about your experience in choosing your A-level subjects. I am interested in looking at the uptake of Science post GCSE and what factors affect students' decision when choosing their A-levels. This discussion, as part of the case study, will be confidential and the reporting will be anonymous, so I hope you can be as open as possible. The interview questions are detailed below.

- Which A-level subjects are you studying?
- What helped you decide which subjects to opt for?
- If a year 9 student asked you what studying Science was like at GCSE (and A-level), what would you say?
- What did your school do to help support you at GCSE when you were making your A-level choices and were the strategies (events/resources/placements) were helpful?
- Did your school encourage you towards opting for a Science career and what could they have done to encourage you more?
- From your personal experience, what was it about the school Science curriculum that encouraged you to choose (or not) A-level Sciences?
- From your personal experience, how did teachers or teaching strategies affect your decision to choose your A-level subjects?
- Looking back, how big a part did the school and the teachers play in helping you decide your A-levels?
- Who would you say helped you in making your decision and how?
- Some of your friends have got good grades in Science at GCSE yet they have not chosen to study any A-level Sciences, can you suggest why this might be?
- Is there anything else you want to bring up regarding the reasons for taking, or not taking, A-level Sciences?

**Thank you very much for taking the time to talk with me**

## Appendix 5 –Tables summarising student responses to questionnaire items

### Self-reported GCSE grades

GCSE Grade	GCSE Core Science	GCSE Additional Science	GCSE Biology	GCSE Chemistry	GCSE Physics	GCSE Maths
A*	0	3	29	25	27	22
A	12	10	25	27	21	25
B	4	3	3	6	11	12
C			1	1	.0	1
D			1	.0	.0	
Total responses	16	16	59	59	59	60

*Table 13 Student's self-reported GCSE grades*

### How important were the following persons in choosing your course?

Person	Not very important	Not important	Undecided	Important	Very important	Total responses
Mum	12	19	10	26	9	76
Dad	12	23	11	22	6	74
Teacher	10	3	13	33	17	76
Friend	19	24	23	9	1	76
Sibling	26	19	8	20	1	74
Careers advisor	41	19	11	3	74	2
Other	16	4	3	5	5	33

*Table 14 Student responses to 'how important were the following persons in choosing your course'*

### How important was each of the following school experiences in choosing your course?

	Not very important	Not important	Undecided	Important	Very important	Total responses
Your interest in the subject		1	3	16	56	76
Your previous attainment in related subjects	1	1	7	43	24	76
Experiments/laboratory work	6	21	32	10	7	76
Field work or trips	14	24	24	9	4	75
Lessons showing the relevance of your subject to society	7	20	20	23	5	75
Lessons showing practical applications of your subject	1	13	20	34	8	76
Using mathematics in lessons	7	21	23	15	10	76
Clear feedback on whether you got the right answer	1	6	11	41	17	76
Going to a careers fair	34	21	15	3	3	76
Researching on your own	6	9	16	34	11	76
Doing an online careers aptitude test	36	20	15	3	2	76
Taster sessions	10	9	15	35	7	76
Work experience placement	27	15	15	13	6	76

*Table 15 Student's responses to 'How important was each of the following school experiences in choosing your course?'*

How much do you agree with the following statements?

Likert statements	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Total
Advances in Science and technology usually bring social benefits	1	3	7	39	23	73
Science is useful for further studies	2	1	6	35	32	76
I enjoy acquiring new knowledge in Science	1	1	3	29	42	76
Science is useful to me	2	1	7	39	26	75
I would like to work in a career involving Science	2	3	19	21	31	76
I would like to spend my life doing advanced Science	5	19	24	16	12	76
I regularly watch television programmes about Science	4	19	18	27	8	76
I regularly visit websites about Science	10	26	24	8	8	76
I regularly borrow books on Science	17	27	17	12	3	76
I am good at Chemistry	4	8	16	33	15	76
I am good at Biology	1	2	12	42	19	76
I am good at Physics	4	12	23	27	10	76
The way Science is taught in lessons makes it interesting for me	4	5	23	30	14	76
At GCSE Science lessons were among my favourite lessons	4		21	51		76
When I had a choice after GCSE, I chose at least one Science subject.	0		0	76		76
What we do in Science lessons is useful whatever you do after you leave school.	3		21	52		76
I like watching Science programmes on the TV.	7		23	45		75
I would trust something a scientist said.	5		53	18		76
It would be good to have a job as a scientist.	6		24	45		75
Science has a positive influence on society.	0		12	62		74
Science makes an important contribution to the wealth of the nation.	5		16	54		75
It is important for this country to have well-qualified scientists.	3		3	69		75
People who do not know much Science are at a disadvantage in today's society.	6		26	41		73

Table 16 Student responses to 'How much do you agree with the following statements?'

## Appendix 6 - Sample transcribed and coded interview

Key for the coding into main themes

Ability Teachers Family & wider society Personal interest School Aspirations

If a code belonged to two or more themes it was included in each (and is underlined).

MD: Thank you for agreeing to be interviewed, Amy. Which A-level subjects are you studying?

Amy: Maths, Further Maths, Chemistry, Biology and English literature

MD: why five?

Amy: Because the school – I was considering further maths and then my maths teacher was like you've done maths early, and you've shown that you can do good maths so you might as well do further maths and if you don't like it, then drop it, you've got nothing to lose. So, it was always sort of 5 but probably going to be 4 and then yeah now we're not allowed to drop it, so that was a lie.

MD: why aren't you allowed?

Amy: The other class got full, so if we drop it we don't really have a teacher. So, we are basically pressured to stay with it, but it's alright, so it's fine.

MD: Ok – could you talk me through each of them and tell me why you have chosen them?

Student: well that's why I chose further maths. I chose maths because I do really enjoy it, by doing the GCSE really it gave me confidence in knowing that I can do some A-level and we also did the AQA certificate of maths.

MD: Was that the extended one?

Amy: Yeah and so that helped a lot of the C1 unit, and so I knew it was going to be ok and I was going to enjoy it. Chemistry and Biology – you know the Morris B test?

MD: No.

Amy: Oh - it's like a test you do and its meant to like show you're true... how you think as opposed to like it shows what you are naturally good at ...

MD: Morris B?

Amy: yeah Morris-B. It tests like your logic thinking and all the different kind of things, and also you do a survey of your interests and stuff and then it kind of like shows you the top 12 jobs you are suited for. Obviously, I don't go completely off that but every time it came up with all the Sciences, so I thought I must be quite naturally in that way of thinking so I

thought about Sciences and then realised yeah I kind of enjoyed them. I didn't really learn that at GCSE because you're not really open to it that much and you don't really know if you're enjoying it because most of it is learning out of the textbook the night before the exam, but yeah that's good. And then English – I took English because I thought I shouldn't take –it would be too horrible to take maths, Chemistry, Biology and Physics. And also like my English teacher told me I was good at it, but really I think he was being nice and now I really struggle at English, and I'm not that good. Yeah.

MD: You said it would be too much for you to take Physics. Too much for who? for you? or just in terms of...?

Amy: For me – as in... because Physics and Chemistry are known to be really hard. I just thought it would be really challenging, the workload, but to be honest, I've found English so hard because it's not linked to any of my other subjects that I probably would have been fine with Physics. But I do enjoy English; I did it also because I like reading, but I don't read that much. So yeah, English is definitely the one to drop.

MD: OK – if a Year 9 student was to ask you what studying Science was like at GCSE and A-level, what would you say?

Amy: comparing them?

MD: Yeah, both what are they like?

Amy: Oh, because they haven't done them. GCSE is a good taster of the things you might learn at A-level and A-level is much more complicated, but if you're willing to work, it's great to learn and understand the world.

MD: How did you find the transition between GCSE to A-level?

Amy: For content-wise, its ok, because you are just shown there is more content, and so you understand what you have to learn but, it's a much bigger step up. No one really explains to you that you need to write in a more sophisticated way and exam technique we're not told that you're just told that you need to improve on it... so I think that transition was quite hard.

MD: Did your school do anything to support you towards a Science career?

Amy: No, teachers in my - because I was in the top set for Science, they just -

MD: top double or top triple?

Amy: top triple. They just said oh I hope you're taking the A-level but not, none of them specifically said you need to do this so you could do Science and to be honest I didn't



necessarily mind. I think they knew that in their class enough people would take Science and yeah. I don't remember anything like that, no.

MD: Do you think they should have or could have?

Amy: I think they could have yeah, shown more examples of careers that are to do with Science, not just medicine and stuff, because people think just be a doctor or an astronaut or something, and show why it could be interesting definitely.

MD: OK – from your personal experience was there anything about the school Science curriculum that encouraged you to take Sciences?

Amy: as in what we learnt? I remember finding space really interesting in Physics, that didn't make me take Physics, but I did find that interesting. I also know that lots of people taking Physics right now say that you don't get to learn about space until next year, so they're a bit disappointed with that. Chemistry if you want to do medicine you have to do Chemistry.

MD: Do you want to do medicine?

Amy: Well, I'm not sure at the moment but something to do with medicine, maybe not a doctor but like biomedicine, yeah something like that. And Biology and Chemistry fit together, I didn't want to do engineering or anything.

MD: OK – what about in terms of assessment or practical work - was there anything about that that encouraged you?

Amy: I don't think so. Maybe in Physics. I keep saying Physics, and I'm not even taking it.

MD: why not?

Amy: no, I found Physics really hard, as in the maths side.

MD: How can you say that when you've taken maths A-level, and further maths?

Amy: I know, I found the like the circuits, you know when I had to figure out the maths on that; I just couldn't get around the maths of it. Maybe that's just because I didn't give it enough time and then ... I did fine in GCSE, I did well but and the like practical's we did in Chemistry and Biology were never umm – dissection was good in Biology, and my teachers were a lot more fun in Chemistry and Biology, so we did quite a lot and how we did better practical's than.

MD: as in they worked?

Amy: yeah and because they made more fun of it than Physics, which was just do it and then pack away.

MD: What did they do in Chemistry and Biology to make it more fun?

Amy: just getting involved with us, the teachers themselves, and showing us why this is in day to day life. I think linking it back to life is quite important because you often hear students go why what the point in learning this, but if you can prove it has a use we're more interested in it.

MD: OK- How did the teachers or the teaching strategies affect you?

Amy: because we were in the top set we were all quite good, and my Biology teacher even said that we teach ourselves, so it was almost like having chats with her every lesson. But they, they made a lot of jokes which was good because it got a lot of students' attention. Like one time my Chemistry teacher said ok, we're making water get your umbrellas out, and then she blew up a hydrogen balloon, and we thought there would be loads of water, and there was a tiny drop. So, just things like that that got us interested.

MD: Wow, that sounds good. How did you know it was just a tiny drop?

Amy: she stood there with a balloon and we all got our umbrellas out thinking, I don't know what we were thinking, that we would get soaked and then bang and we were like where's the water and she was like we just made like the tiniest amount, and she explained how.

MD: much energy you can make from the process – brilliant. Looking back how big a part do you think the school played in your A-level choices?

Amy: to be honest the fact that I did that Morris B test was because I felt that the school was not guiding me enough. I mean I could have spoken to more teachers if I wanted but at the time if you were doing quite well or even out of your subjects they always just say the same thing to you they just say what are you interested in. But you don't really know, so yeah. I don't think... they tried to help, but I don't think they could say anything different to the next teacher because they see your work in class and that's about it. They were really encouraging in telling you to take what you enjoy which was really good because you need to do something you like at A-level, that's what I remember them saying.

MD: where did you hear about the Morris B test?

Amy: my friends mum found out about it, like quite a lot of parents know about it. I think in some private schools. I think because they are paying all the fees they get people in to do it for all the kids. So, I think they heard about it through other kids and so we all got a group of them together, and if you get a big enough group, they bring the test to you. So, we did it at school, but it wasn't to do with school.

MD: So, is it analysed on the spot or...?

Amy: Oh, no. You do the test under like really close timings and then also the survey thing for interests and then they take it away for I think like two weeks, and then they produce like a whole booklet for you and it's got like all these charts of your different thinking, like logical and all those things, and then has all the careers and then also all the courses that would be recommended for you at different universities. So, it was really useful, and also, it gives you numbers of unis to call. So, it's good, it's like worth it even though it takes like two weeks you get like a whole booklet, that I even look at now.

MD: Did you try any other aptitude tests on the internet?

Amy: No, not really.

MD: OK, but this one came recommended?

Amy: Yeah, my mum said, yeah, well we might as well do it.

MD: that's brilliant – ok so who was it then that you spoke to about your decision-making process overall?

Amy: Well, there was a person after the Morris B test who you have a meeting with and the first person I talked to properly about this was her, I can't remember her name but that's when I was weighing up between Physics and the rest, and also geography or something like that. Then I realised that's probably the main, the five I chose now are probably – I know I wanted to take it – I realised, I didn't need English, but I knew I wanted to take it, and it thought it would be a different one, sort of more creative. I also went to an engineering course for girls, for Physics and there we spoke about options, and then I realised that even if I wanted to do engineering like chemical engineering or something I wouldn't even need to do Physics. I also went to some art fair in Islington, and there were lots of engineers there, female ones and I was speaking to them, and a lot of them had just done art and Chemistry, so they showed me and gave me ideas for options. As in realising I could do a lot with Chemistry. And then my parents, I spoke to a few teachers and then I came to my decision.

MD: You've spoken to quite a lot of people. Was that a personal drive from you to do that?

Amy: Yeah. Because well, my mum encouraged me to talk to lots of people because I was like I don't just want one opinion. But yeah, I wanted to get a range of opinions and also experiences from people.

MD: How did your mum help?

Amy: Well, actually they were quite encouraging for me not to take Science. Because both my parents do like art and film and stuff, so they sort of wanted me to go down the English and art route, so I guess that's partly why I took English, to be honest. But then they realised she probably does want to do it so because she didn't have any experience in Science she wanted me to talk to other people, who could actually help me.

MD: OK – that makes sense. Some of your friends have got good grades in GCSE Science – this is an assumption – but they didn't choose it at A-level. Firstly, is that true and secondly why do you think they haven't chosen it?

Amy: yeah, a lot of my friends did get good grades but say they hated it. I remember my friend said throughout the whole year she hates Physics like properly with a passion but could never do it, ended up getting an A\* in Physics and like a B and an A in the other two. So, maybe she did hate it and was somehow great at it, but I think, yeah the course is presented; it just comes across too tedious, quite repetitive I guess at times. Sometimes it's too general knowledge, that maybe they just think this is just general knowledge and I don't need this at all when I'm older so why do I need this? I think a lot of the time it's linked with you only take up Science because it's linked with that career. Obviously, you need to take A-levels that you might want to do, so a lot of people think I'm going to do English or whatever they just completely rule it out and don't consider it, even when they're taking their GCSEs.

MD: You said the course was repetitive – what kind of examples?

Amy: I meant like maybe there's a bit of overlap between two of the units in each one... maybe because it's triple Science or something? Just when you're answering the questions, its often the same thing, like in some of the tests and people get bored of that. But obviously if you need to make it like that I'm not complaining it makes it easier, but, yeah.

MD: do you sometimes think if it's too easy it puts people off?

Amy: Yeah for certain people definitely, because they need to stay engaged and so in class, it puts them off because it's so easy and then they don't do well, it's because they haven't learnt it in the lesson. So yeah, definitely, too easy put people off.

MD: Is it too easy?

Amy: The GCSE?

MD: Yeah.

Amy: I didn't think it was too easy because there were parts where I found it hard some of it was very easy but some of it needs to be easier than other bits, I guess. That's why they have the triple course as opposed to the double, so that's ok.

MD: Ok, was there anything else that helped you or anything else about taking the A-levels that you wanted to bring up?

Amy: I don't think so. Doing it for a career, I guess, influenced me more than doing it for my choices, even though I knew I liked it. I think at the time of choosing Chemistry I didn't really enjoy it I took it because I just knew I needed it. Now, I do enjoy it which is lucky, but I was taking it because I will need it for later life.

MD: Is that because you are considering a medical kind of career?

Amy: Yeah

MD: When you went to those engineering events you didn't choose engineering in the end. Was there something that put you off or something that didn't grab you?

Amy: To be honest the course wasn't very good. They presented themselves as we would be learning all these unique things and we ended up just sitting there making bridges out of straws and cello tape. Yeah, it was fun, but...

MD: How old were you?

Amy: It was last year, year 11. We had finished GCSEs even. It was fun to meet other girls in the London, but other than that, it felt like we could have done this anywhere.

MD: How did you feel about it just being a girl's trip?

Amy: I know it was because they were trying to encourage girls into engineering, so that was nice, it was quite nice to get together with Science girls I guess.

MD: Is there anything else you want to bring up?

Amy: No

MD: If you do think of anything, please e-mail me. Thank you very much for your time.

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Appendix 7 – Table showing quotes from the students interviews that related to ability and organised into their emerging subthemes.

Subthemes	Quotes from interviews that relate to the overall theme of ability
Attainment	<p>"I mean, kind of, my GCSE results because I wanted to do another Science. But I got a B in Physics and an A in Chemistry, and so I chose Chemistry naturally because I did better in it."</p> <p>"I mean I was good at it, but I barely tried for maths GCSE, even though I got an A like."</p> <p>"...especially Physics, because I had absolutely no clue what was going on. And then I managed to get like full marks, and I generally didn't understand anything, and I was a little bit confused."</p> <p>"I think so, but I got an A in Physics."</p> <p>"I thought, I got an A* in Spanish."</p> <p>"I chose maths because I got an A, it goes well, and it's academic."</p> <p>"That one was mainly a space filler, sort of. I got a good grade at GCSE."</p> <p>"Drama, but I really didn't do that well, so I decided, like, maybe that's not for me. So, I chose what I was good at."</p> <p>"At first I was undecided, up until my MOCKS came. Then I was like; I knew where my strengths were."</p> <p>"...like 'you got an A for GCSE, you might not be up to scratch', but if you got the grades, I think they were like 'you can take this subject its fine.'"</p> <p>"I did fine in GCSE, I did well."</p> <p>"But actually, in GCSE I didn't get a suitable grade to take Chemistry. Did you know that? Because of the coursework. I got a really low grade in the coursework. And they didn't allow me to retake it, so it bought my grade down a lot. I had to prove to them that without my coursework, my grade would have gone a lot higher."</p> <p>"I chose Maths because I'm good at it, I suppose. In GCSE, I got an A* so I thought I might as well carry it on."</p> <p>"For example in maths, Chemistry and Physics I got A*'s, and I got A*'s in other things as well. For example, Biology I got an A, but I didn't enjoy Biology as much. So, I knew if I were going to pick two out of the three Sciences, which I did, then Chemistry and Physics would be the ones to pick. Apart from maths, I didn't pick another subject that I got an A* in."</p> <p>".. because I achieved well in it at GCSE. I picked the best subjects. I got like 4 A*'s and it was Science and Maths, I took them for A-level."</p> <p>"I picked sociology because I think I did well in it last year."</p> <p>"I didn't get a good enough grade."</p>

Early success motivators	<p>"by doing the GCSE early it gave me confidence in knowing that I can do some A-level, and we also did the AQA certificate of maths."</p> <p>"...and we took our Maths GCSE a year early, and in the year where everyone took their GCSE we took a further maths qualification; which encompassed quite a lot of maths A-level and sort of some of the further maths. So, they told us would be quite bored and a lot of it would be revision if we just did single maths, and I like maths anyway."</p>
Capability for further study	<p>"Well, I didn't want to take the subjects where I thought I wouldn't be able to cope. Because stuff like languages, I took two languages at GCSE. But I was only good at them because I was able to memorise large quantities of things, and then read it off. I wasn't able to just speak it off the top of my head, and then with stuff like English, I could also do, but I got more frustrated."</p> <p>"And I could do quite well at it."</p> <p>"I think for A-level I've got friends who do it and no way!"</p> <p>"Physics I dropped because I didn't think I would do well."</p> <p>"So yeah, but I doubt that I would be able to do an actual A2 in maths, but an AS would be OK if I stretch it out over two years. It would be too much for me this year, so I'm going to do it next year if I can't."</p> <p>"I just thought, I should just focus on what I was good at rather than like doing what could potentially fail me."</p> <p>"Well, while I was studying my GCSEs maths was always a strong point, for me. Biology was strong, and history was strong, so it was always... So, there was always going to be some sort of working of those things. But I was strong in other subjects as well. So, I suppose I started narrowing down from my GCSE subjects before I got my exam results because I kind of knew how my exams had gone. And by the time I finished all the course content for all the GCSEs I did, I felt that Chemistry, Biology, history, maths and further maths were the right choices for me."</p> <p>"I took them all at GCSE, and I don't know...They were just subjects I thought I could do well in."</p> <p>"And my maths teacher was kind of going, 'oh well I'm not sure how well you will do in maths' and stuff like that."</p> <p>"For medicine, like the option, was between Further Maths and like Physics. And I'm more likely to be better at Maths than Physics."</p> <p>"It's just about right for me, so if I go any higher, it's going to be too hard for me. And I'm going to get a bad grade, and I feel like they keep being told like I was told myself, that lot of people who got good grades in GCSE get A*'s got U's and E's when they got to A-Level. That makes you think if you want to take the risk."</p> <p>"I'm good, but I work at a slower rate, than other people slightly, but I think I've got potential."</p>
Aptitude	<p>"Well, I didn't want to take the subjects where I thought I wouldn't be able to cope."</p> <p>"You can do good maths. So, you might as well do further maths."</p> <p>"You know the Morris-B test? It's like a test you do and its meant to like show your true... how you think as opposed... like it shows what you are naturally good at."</p> <p>"The Sciences came more naturally to me."</p>

	<p>"I am just weirdly good at maths, so I did maths."</p> <p>"OK, I've always felt I've had a skill for drawing and art. But more, like, I felt like drawing. And I always had a more logical mind. And so, for my GCSEs I did art, but I felt that it was too free I wanted some structure and design to a brief. So, I thought; for my A-levels, I'd do product design."</p> <p>"I've always been reasonably good at maths, so I chose maths."</p> <p>"I thought I was good at it."</p> <p>"I don't know. I've been quite good at it, so I really wanted to do that."</p> <p>"Maths. I've always been quite good at maths."</p> <p>"You know if you're good at it, I would do it. You know what I mean?"</p>
Apparent ease & difficulty	<p>"Now I really struggle at English, and I'm not that good. "</p> <p>"No, I found Physics really hard, as in the maths side. MD: How can you say that when you've taken maths A-level and further maths? Student: I know, I found the like the circuits, you know when I had to figure out the maths on that, I just couldn't get around the maths of it. Maybe that's just because I didn't give it enough time..."</p> <p>"Well, I took maths and further maths because I was in set 1 for GCSE."</p> <p>"Because we were in the top set, we were all quite good, and my Biology teacher even said that we teach ourselves,"</p> <p>"I didn't think it was too easy because there were parts where I found it hard some of it was very easy but some of it needs to be easier than other bits, I guess. That's why they have the triple course as opposed to the double, so that's ok."</p> <p>"It's quite hard."</p> <p>"But there is a giant step up between GCSE and A-level, particularly in Biology, I think because a lot of people do it because they think it's quite easy but it's quite content heavy and like a lot of people have been getting U's and stuff in my class so yeah."</p> <p>"I think the Science ones were quite easy. "</p> <p>"I just thought because I dropped Physics ill choose something easier."</p> <p>"At the time of my GCSEs, I felt that Physics was not my strongest subject out of Biology and Physics and so I chose Biology "</p> <p>"Probably a bit of both I quite enjoy finding stuff hard and then being able to complete it "</p> <p>"Honestly I found it quite easy (Science), I didn't find I could learn that much in class, I could just learn the revision book a couple of weeks before the exam and that's all you had to do. In honesty, that's all I did."</p> <p>"Physics and Chemistry are known to be really hard. I just thought it would be really challenging, the workload"</p> <p>"Biology was the easiest one compared to the others."</p> <p>"With photography, that was just spur of the moment. It's nice to do something which isn't too serious compared to your other subjects."</p> <p>"I find Maths quite easy, a subject I'm good at, so I thought I should take it, and further Maths."</p> <p>"People who like didn't pick triple and did double Science they were made to believe that triple Science is really hard and so when people who were doing like BTEC were told 'don't do triple Science it's really hard' so they were like a step higher is going to be harder. In like triple</p>



	Science, we were told like A-Levels is a big jump, people who were double Science were told triple Science is harder, it wasn't much harder it was on extra topic, but they were told we were doing a harder thing, so they were thinking this 'I've been told the next steps harder, and I already find this quite difficult.' 'I really struggle at English, and I'm not that good'
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Table 17 Quotes from the students interviews that related to ability and organised into their emerging subthemes.

## Appendix 8 – Notes on individual trajectories & subject combinations of the students interviewed

Trajectory	Description of trajectory	Student code	Brief summary of their personal trajectory	Subjects studied
Direct	These had chosen high visibility occupations. These students had either strongly decided on a career or at the very least the degree that they wanted to study at university. These students displayed the most stable subject commitment.	School B – F1	Wants to become psychologist and looked up subjects around that as well as followed instinct of what would be suitable	Biology Maths Psychology Philosophy
		School B – F2 Twi	Wants to be a marine biologist, but aware that if she chooses to change her mind she isn't limited with her combination of choices	Biology Chemistry Sociology Psychology
		School B – F3 Ella	Wants to be a vet but also worried that she may not have grades for it, and is aware of usefulness of other subjects in studying bioChemistry or biomedicine if that doesn't work out	Physics Biology Chemistry Philosophy
		School B – F4	Wants to be a medic but aware that wasn't certain so would go to study maths if that wasn't possible.	Maths Further Maths Chemistry Biology
		School B – M1	Wants to study psychology at university and stated that was his overarching influence. The exact combination of subjects came partially through precipitating trajectory	Psychology Biology Chemistry Philosophy
		School B – M2	Wants to study Sociology at university. The other subjects were made on a range of factors focussed on usefulness.	Math English lit. Biology Sociology
		School B – F5	Wants to be a doctor and chose subjects with that purpose despite not liking Biology.	Maths Biology Further Maths Chemistry
		School A – F1	Wants to be an engineer, wasn't sure which specialism. As she enjoyed all Sciences studied them all to keep her options open.	Maths Further maths Physics Chemistry Biology
		School A – M1 Timothy	Wants to be a doctor or work in the medical profession chose subjects that would give him skills required and would be perceived well by universities.	History Biology Chemistry Maths Further maths

partially resolved	Students had not necessarily chosen a career but were aware of the usefulness of their subjects for future study and careers.	School B – M3 Gareth	Interested in courses based around maths and Physics. Possibly engineering or computer programming, but not sure yet.	Chemistry Psychology Physics Maths
		School B – M4	Interested in engineering but not actually fully decided so wants to keep his options open by choosing subjects he can choose to apply to anything and avoiding PE and psychology which would have limited him.	Maths Biology Chemistry Physics
		School A – F2 Amy	Inclined towards medical/biomedicine but not engineering. Does enjoy the Sciences, but chose them for a career rather than doing it because she knew she liked it.	Maths Further maths Chemistry Biology English lit.
		School A – F3	Was originally considering medicine, so chose two of the Sciences for that. English literature because she wanted to something more creative and psychology because she was interested in how people think.	Biology Chemistry English lit. Psychology
		School A – F4	Interested in zoology or biological illustrations. Not completely sure but enjoys art.	Biology Maths English lit Physics → art
		School A – F5	Interested in philosophy for further study, but chose others as she enjoyed them. Not yet chosen a career.	Philosophy English Geography Biology
		School A – M2	Wants to study Physics at university or something Physics related and further maths goes well with Physics. Chose Biology because just in case he changed his mind about Physics.	Maths Further maths Physics Biology
funnelling identifier	Student used a method where he narrowed his choices over time.	School A – M3 Lucas	Narrowed his options based on his skills and interests for drawing and designing products. In terms of his future, he considered his future economic wellbeing and decided that engineering would be best.	Physics Maths Product design Spanish
multiple projection	Students continually changed their minds about subject choices or careers.	School B – F6 Shaniqua	Initially considered media, then health and social care, then nursing. Considered what she enjoyed as well as future economic well-being.	Biology Chemistry Sociology Psychology
		School A – F6	Chose her two favourite subjects, geography and Biology. Then considered Chemistry because she wanted to study natural Sciences, but is leaning more towards geography again now.	Geography Biology Chemistry Maths
precipitating	Students based their A level choices on interests or skills, without deciding what they would like to	School A – M4	Chose subjects based on strong interest but no real notion of what he wants to study or be when older	Psychology Biology Chemistry History
		School B – M5	Chose subjects based on what he enjoyed and what he wanted to study but looked up careers once he was on the course and then tried to work out what he could go into using what he had.	Philosophy Psychology Photography Chemistry

	study at university or pursue at as a career.	School A – M5 Nathan	Simply chose what he was interested in most, then for fourth one decided to go with what he had got a good GCSE grade in.	Maths Chemistry Biology Geography
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*Table 18 Notes on individual trajectories & subject combinations of the students interviewed*